Santa Barbara Audubon Society

Nest Box Program Report

2022

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January 2023

Acknowledgements

Jan Wasserman, whose presentation of her work in Ventura inspired the beginnings of our program in 2005.

Dr. Don Schroeder, who brought a scientific underpinning to the project, prepared the basic training materials for the citizen science aspect of the project, and has directed the banding portion of the program; as well as has regularly contributed to maintaining and running the project since the beginning.

David Kisner and David Eldridge for their efforts in getting the project going and building some of the initial boxes.

Elaine Tan, who as a UCSB undergraduate contributed significantly to keeping the program running smoothly for over three years.

Andy Lanes and **Richard Figueroa** for their contribution in getting the citizen science program going with UCSB students.

Betsy Mooney, Jayne Wamsley, and Peter Thompson, for all their support and sticking with it over the years.

Michelle Cyr, who organized the time-line portion of the data.

And the 2021 & 2022 teams that helped with the banding and box monitoring: **Conor McMahon**, **Asher Thompson, Carolyn Chaney, Kate-Karol-Ivona-Agnes Stawiecki, Megan Norman, Valerie Watt, Alex Castelein, Jeremy Cowan, Kris Brunell, Max Laubstein, Steve Wheeler, Virginia Gardner, and Chuck Cagara.**

And the many other volunteers who have participated over the years.

Abstract

An array of nest boxes at Lake Los Carneros, Goleta, California acts as a scientific monitoring instrument utilizing TRES and WEBL as vectors to evaluate aspects of their lives and the quality of their environment over time.

The basic monitoring results are presented for 2012-2022.

As well, a smaller subset of monitoring data is presented from COPR (Coal Oil Point Reserve), located nearby, for the years 2012-2017.

Some figures of merit - Numbers Fledged, Numbers Fledged per Box, and Fledging Efficiency are proposed for analyzing this monitoring data.

Additionally, banding data from LLC is presented for the period 2017-2022. Banding activity was reduced in 2020 due to the Covid 19 pandemic.

From the banding data, the different mating strategies of the TRES and WEBL are compared, an estimate of their AWLS (Average Wild Life Span) is deduced, and a rough estimate of Sustainability Index for the TRES population at LLC is calculated.V

Data from Cornell University's eBird database is then used to provide a larger, contextual framework to possible interpretations of what we have observed and surmised.

Introduction and Background of the Program

This project is just one of many nest box projects, in various parts of the country, that vary greatly in methodology and exist at different levels of conservation and science. It has evolved from being purely conservation to significantly a science project; as we tried to better understand what the birds were showing us.

The results presented here are part of an ongoing exploration and are not meant to be a tightly controlled, academic research; but rather to get some reasonably accurate understandings of the TRES and WEBL's lives, focused on nesting and reproduction; as well, some basic idea of their typical lifespans and sustainability in our area. Our area, Goleta, CA., has a relatively dry, moderate climate and therefore, some of what we observe may be different from other areas, say, with a shorter, wetter season.

Just as, with each step in our progress, we have seen new relationships to explore, perhaps our results will provide others with questions of their own to pursue.

The seed of our project began in 1985 with Jan Wasserman setting out nest boxes for TRES (Tree Swallows) in Ventura/Oxnard; as their numbers in the area had seemed greatly reduced due to loss of nesting habitat. Eventually nearly one thousand boxes were placed, resulting in ten thousand fledges over twelve years.

In 2004, she spoke to SBAS (Santa Barbara Audubon Society) about her work. This inspired David Kisner and David Eldridge to begin a nest box program here the next year. Over the next years, more than thirty boxes were built and installed at LLC (Lake Los Carneros) and

COPR (Coal Oil Point Reserve). Dr. Don Schroeder systematized the monitoring procedures and created a database of the results.

In 2012-2015, as SBAS Science Chair, Andy Lanes expanded the program to include UCSB students as citizen scientists. This approach was continued by Richard Figueroa. At that time, there were 20 nest boxes at COPR and 11 at LLC.

In 2016, as SBAS Science Chair, Steve Senesac, reorganized the database to better evaluate the efficiency of individual boxes and looked at ways to better motivate the monitoring volunteers. This resulted in an easier-to-use box design and a reorganization of box locations resulting in 16 boxes at COPR and 14 at LLC..

In 2017, Dr. Schroeder began a program for banding the TRES and WEBL at LLC. The banding data allows us to conservatively estimate the TRES's lifespan in the wild; and it gives insight into the particular inclinations of the TRES and WEBL with respect to mate and nesting site selection in our area; as well, gives some indication of the sustainability of the TRES population locally.

In trying to better understand the implications of the banding data, we have used population data from Cornell University's eBird application to create a larger, reference context for our local data. We have also included a reference species, the Black Phoebe (BLPH); which, while being similar to the WEBL and TRES in size and predominately insect diet, is not a cavity dweller; but rather tends to nest under overhangs, natural and human-made; which presumably, would make it less directly affected by tree trimming and brush clearing.

Unfortunately, before the 2018 nesting season, we were required to remove the boxes from COPR due to COPR's concerns about the safety of the birds and satisfying IACUC (International Animal Care and Use Committee) regulations. This prevented a more direct measurement of the impact of the conversion of the bordering Ocean Meadows Golf Course into its original wetlands – now North Campus Open Space (NCOS).

The closing of the COPR part of the program resulted in placing eight of those boxes at LLC, resulting in zero boxes at COPR and 22 at LLC. This situation has remained stable through the 2018 to 2022 nesting seasons.

TRES and WEBL

Initially, the nest box program focused on TRES (Tree Swallow), possibly because, at the time, it is the rarer species here. However, it became apparent that it would be interesting to include the WEBL (Western Bluebird) as well, for comparison, as they respond to a bit different habitat; yet have the same interest in a nesting cavity (nest box) with a 38 mm (1 ½ inch) diameter hole and roughly 13 cm x 13 cm interior dimensions.

TRES like to nest in tree cavities or nest boxes. While they seem relatively aggressive, they also seem to adjust easily to being closely observed (lowering their box and moving around their nestlings to count them) even daily (although we generally only monitor them twice a week). For example, it has become increasingly common for the female to stay on the nest when the nest box is lowered and opened.

At the same time, especially when the nestlings are present, the TRES will often ‘dive bomb’ us, making sounds like demented sewing machines. That they exhibit ‘mobbing’ behavior is common – as many as six or eight birds may combine to drive intruders away.

They seem to prefer open land adjacent to water. Being agile flyers, they can generally avoid raptors if they have enough reaction time and space to do so (but not always). They generally feed by capturing insects in the air.

They are territorial around an active nest box during nesting season but are communal otherwise and may feed in flocks away from the nest boxes.

They use various quantities of feathers to line their nests – from less than ten to more than fifty. It would be interesting to see if there is any correlation between numbers of feather lining the nest and fledging efficiency.

The adult males and females resemble each other. When banding, one can generally determine the sex by blowing on the feathers of their breast. The breeding females will have a bare spot (the brood patch) on their chest-abdomen. Young, adult females also tend to be browner.

They often, but not always, change mates in subsequent seasons; but generally, stay with the same mate when they have a second nest in the same season. Sometimes they take on a new mate because their previous mate has gone missing; however, counter-intuitively, they will often change mates, even though their previous mate is in the area.

They have a nestling mortality rate of around 40% (in our area) and commonly have two nests, sequentially, in a season.

They migrate from Mexico and Florida into North America and Canada and back. (See Appendix 5 for details.) ***In this migratory behavior, they differ from the WEBL and BLPH***, who only minimally expand and contract their ranges through the seasons. (Again, see Appendix 5 for details)

WEBL also like to nest in tree cavities or nest boxes. They seem generally less aggressive; but in one or two cases have evicted a tree swallow from its box, even removing all the feathers and dropping them on the ground in front of the box. However, generally, it is the TRES that push out the WEBL.

WEBL generally eat ground insects or berries. While territorial around their nests, they can assemble in small flocks to feed.

They do not line their nests with feathers and use somewhat coarser grass for their nest than do the TRES in our area.

The males and females look different.

They tend to keep the same mate and nest box for several seasons. They tend to have much less nestling mortality than do the TRES and they generally only have one nest (but not always) in one season.

They do not migrate per se; but minimally expand or contract their range depending on the season. See Appendix 5 for details.

BLPH, Black Phoebe, were not directly monitored in this study; but were included in the eBird data to act as a reference species, in that they are similar in size to the TRES and WEBL, eat insects, are plentiful and easy to identify; but nest under overhangs, both natural and human-made; thereby probably not being so directly impacted from tree trimming and brush clearing as might the TRES and WEBL, being cavity nesters.

Technical Background of the Program

Box design

The original nest boxes were a mixture of design concepts.

 **Fig 1a – Box C02 COPR**	 **Fig 1b – Box C14 COPR**	 **Fig 1c – Box C13 COPR**
 **Fig 1d – Box L12 LLC**	 **Fig 1e – Box L14 LLC**	 **Fig 1f – Box L01 LLC**

Some of the boxes were side-opening, hinged at the top. Some were side-opening, hinged at the bottom, and some were top-opening. We wished to standardize the design and to make the nests easier and safer to observe, and to eliminate box design as a variable in later analyses.

With the new design, we chose to have the box top-opening as 1) it allowed for a better viewing angle of the nest and its contents, and 2) one could monitor the nestlings even when they were late-stage with little risk of them jumping out – safer for the birds.

With the new design, we also eliminated the heat shielding shadowing the sides of the box as some testing showed that the 15 mm thickness of the wooden sides and top was sufficient insulation; and that the internal temperature of the box was determined by ambient air flow.

We also standardized on the base of the box being a square with sides of 13 cm – judged the minimum for late-stage nestlings to stretch their wings comfortably.

Finally, we changed the support-pole design. The previous design had a smaller diameter pipe sliding down into a larger diameter pipe. A hole through both pipes allowed a bolt to secure them in place when the box was raised. This bolt was removed when the box was lowered.

There were three problems with this system.

1) as rain water and condensation ran down the smaller diameter pipe into the larger diameter one, it would fill up with black, smelly, slime; thus, when the top, smaller diameter pipe-piston went down into it, it squirted all over one's hands and, sometimes, clothes.

2) in raising the small diameter pipe back up, it was difficult to align the holes in order to push the bolt back through – especially as the pipe was now coated in black slime.

3) even when fully lowered, the box height was such that any observer less than about 165 cm (5 ft 5 in) tall had difficulty to see down into the box (top opening)

This was solved by having the smaller diameter pipe fixed for the entire height; while a short section of larger diameter pipe simply slid over it, to whatever height one wanted. We more or less, arbitrarily, chose that height so that a person of about 140 cm (4 ft 7 inches) would be able to see into the nest.

New Box in Operation

Fig 2a Box Raised

Fig 2b Box Lowered

Fig 2c Box Opened

Fig 3a Box in Operation: Feeding Time

Fig 3b Box in Operation: Hanging Out

Box Placement

Birds, like people, seem to have preferences about where they live. Some like to be close to others of their own kind, some prefer some distance, and some like to be really isolated. TRES and WEBL like a moderate amount of distance between nests – 20 to 40 meters. TRES like to be near a body of fresh water. WEBLs do not seem to care so much.

The TRES seem to prefer being at least 10 meters from any vegetation taller than 2 meters, perhaps to give them some reaction time from attacks by raptors and some distance from the habitat of house wrens, who can take over the nest and destroy the eggs.

They also seem to prefer that the nest box be at least 1.5 meters above the ground.

It is important to note that individual TRES have their own personalities; so, there is a range of behaviors exhibited around these common trends.

An example of the importance of having sufficient space between the nest boxes is given in Figs. 4a and 4b.

Fig 4a LLC Nest Box Locations 2012-15

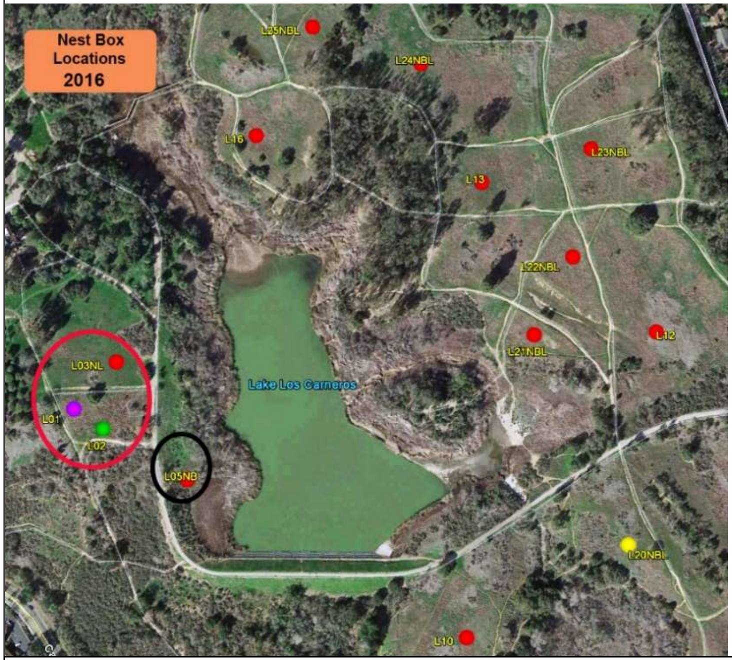

Fig 4b LLC Nest Box Locations 2016

The colors of the dots in Figs. 4a and 4b indicate the number of nestlings fledged per year for that particular box.

- 🔴 3 or more fledges per year
- 🟣 2 to 3 fledges per year
- 🟢 1 to 2 fledges per year
- 🟡 0 to 1 fledges per year

Comparing the boxes within the Red Ellipses, we can see that the boxes were spread more widely apart in 2016, resulting in boxes L02 and L03 increasing their number of fledges and box L01 remaining the same.

Comparing the boxes within the Black Ellipses, removing box L04, which had only been 4.5 meters from Box L05, resulted in an increase from 2 fledges total for the two boxes to 3 fledges for just box L05 in 2016.

The above supports the hypothesis that, when the boxes are too close together, the birds spend more energy hassling each other and less in maintaining their brood.

Finally, in 2018, with the addition of the eight boxes from COPR, the box locations were stabilized and have remained the same till today (2022). The final arrangement is shown in Fig 5.

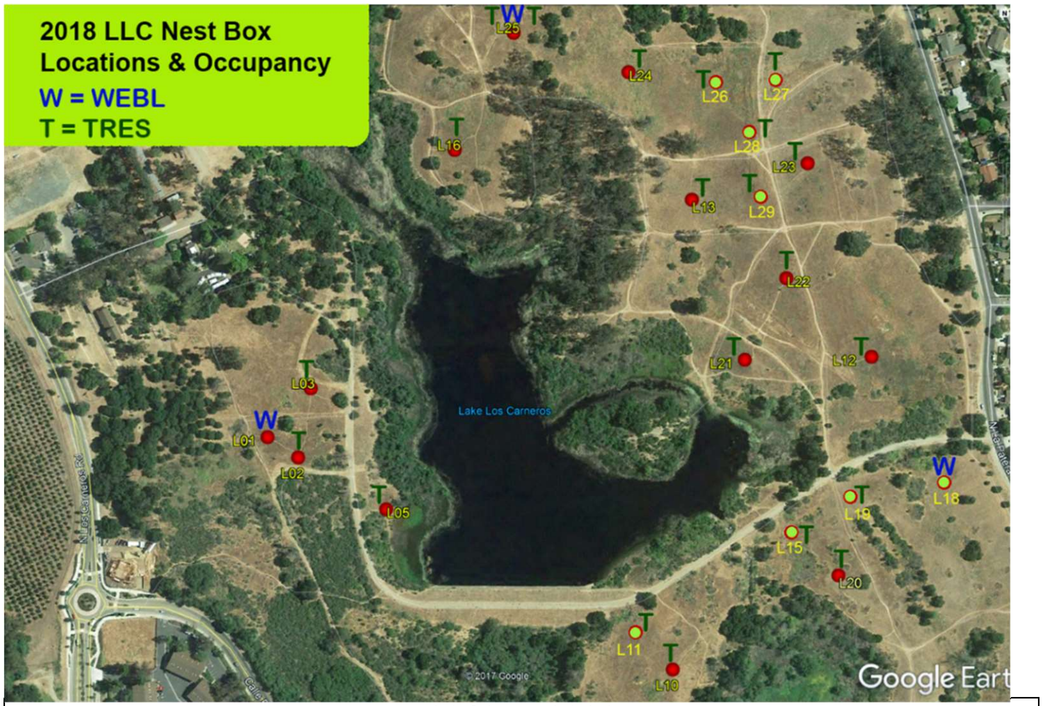

Fig. 5 Nest Box Locations 2018 to 2022

Note that the Red Dots denote existing boxes and the Lime-Green Dots are the eight new boxes from COPR. The T's denote the box was utilized in 2018 by TRES and the W's are the WEBL's. Box L25 is designated TWT as it switched back and forth in 2018 – it has typically been a 'battleground' box. In 2022, boxes L03 and L23 were TWT, with the WEBLs eradicating the feathers and nestlings of the TRES nest in L23.

In Fig. 5, one can see that the WEBL's only occupy the outer-most boxes from the lake. This has remained generally true. Some boxes, like L13, are contested early in the season; but, so far, the TRES prevail with few exceptions.

Various aggressive behaviors were observed both within species and between WEBL and TRES. TRES were observed competing with each other for specific boxes – clasping each other in the air and tumbling to the ground, or a pair sitting on a nest box roof, being dived at by other TRES. But also, having the feathers plucked out a TRES nest by WEBLs who subsequently built their nest on top, or in one case, not only the feathers, but early stage TRES nestlings were plucked out as well. But generally, in WEBL-TRES conflicts at LLC, the TRES prevail by harassing the WEBL till the WEBL abandon the nest box.

All of this, even as a few nearby trees with nest-cavities remain unoccupied by either TRES or WEBL. That is to say, that ***apparently the WEBL and TRES view the nest boxes as far superior habitat to naturally occurring cavities***. This has significance in the later discussions about lifespan and sustainability.

Nesting Behaviors

TRES and WEBL differ in more ways than just the TRES's preference for placing a feather lining within their nest.

In our area, at least, it is common for the TRES to create a second nest on top of the first nest, in the same season, after the nestlings from the first nest have fledged. Whereas, the WEBL seldom do this.

Because Dr. Schroeder has been banding the birds, it has been possible to keep track of some of them individually.

Reviewing Appendix 1, while the TRES typically seem to keep the same mate for the 2nd nest cycle; **they seem to most often, but not always, change mates in the subsequent years**.

The WEBL, on the other hand, tend to keep the same mate for several seasons and return to the same box.

The TRES, at LLC, have a higher nestling mortality rate than the WEBL; but because they often have a second nest, tend to fledge a similar number of birds per box, in a season, as do the WEBL. (See Figures 6 & 7 for details.)

When we put these three things together (TRES changing mates, producing more eggs, and having a higher nestling mortality), the TRES are likely to be producing much more genetic diversity and therefore, a quicker evolutionary response to changing conditions than do the WEBL. Due to the apparent rapidity of climate change, we may actually be able to observe some evidence of this over one of our generations.

Methodology

Depending on the number of volunteers available, monitoring was done either once or twice a week. Monitoring less than once a week significantly impacts capturing the timing of the events.

Monitoring consists of checking each box and writing down, on the pre-printed form, the contents of the box, as well, what is going on in the surrounding area – see Appendix 7 for more details. After each monitoring session, the data are uploaded into a Google Sheets spreadsheet. At season's end, this is copied into an Excel spreadsheet with templates for doing the analysis.

Banding takes place under the supervision of a licensed bander or sublicensee.

If the nesting stage is 'nestlings 4-to-11 days after hatching', then we attempt to capture the adults when they enter the box. For this, a shutter mechanism at the box entrance hole is activated with a long string. When the nestlings are 9-to-11 days after hatching, they are removed from the box, weighed, banded, and then returned to the box. Captured adults are weighed, banded (or have their existing bands recorded), and quickly released.

Results

Different results can be obtained depending on how the data are arranged.

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"… and it does 1,200 miles on a tankful of gas."

There is a story about 5 blind people describing an elephant. One felt its tail, another its ear, a third its trunk, a fourth its leg, and the fifth its side. They each had rather different descriptions. It was only by putting the descriptions together that a more accurate concept of the elephant emerged.

Likewise, there are different ways to present these data – each gives a different perspective. By taking them together, one gets a more comprehensive insight into the larger reality.

Different ways to view these data:

Initially, the emphasis was on collecting data on when the nest was started, completed, the first egg laid, when and how many nestlings fledged; so, the data were simply entered chronologically - in the order that the boxes were monitored. From this, it was relatively easy to find when the first fiber was placed or the first egg laid; but it was difficult to determine which boxes were the best producers or, for example, how effective the heat shielding was.

In 2016, we began entering data by box number (and reorganized the years of previous data into the same format). In this way, we could determine which box locations were the most efficient at producing fledged nestlings.

Thanks to input from one of volunteers, Michelle Cyr, we created columns to the right of the raw data in our spreadsheet to track specific events, such as first fiber and first egg (temporal); as well as how many eggs were laid, how many hatched, and how many nestlings fledged for each box, etc.

In 2017, when Dr. Schroeder began the banding, we could then track individual birds and discover who was mating with whom, and get some idea as to their lifespan in the wild.

These different perspectives, when taken together, give some dimensionality to what is the life of a TRES or WEBL. There is more; as with most things, the more you look, the more there is to see. In analyzing the data, we looked at trying to establish a ‘sustainability index’ and this led us to examining the implications of the relatively large number of “AHYs” (After Hatch Year) – adult birds captured for the first time in our boxes; rather than more birds that had fledged from our boxes. We then downloaded databases from Cornel University’s eBird application to look at the global, regional, and local population distributions of the TRES and WEBL. After viewing these is data, we then downloaded data on BLPH (Black Phoebe) in order to better compare the TRES and WEBL data.

First Level Results

We needed a way to determine how ‘successful’ the individual nest boxes were; in order to then determine if we were improving conditions, or not, by changing the box designs and locations.

The obvious, and common, way to evaluate ‘success’ is to look at how many birds fledge each season. However, as the above cartoon implies, this simple metric, by itself, is flawed. For example, if you had 100 fledges from the program, it makes considerable difference if it was from 50 nest boxes or from 500 nest boxes; or if it was in one year or from 10 years. The following graphs in Figures 6 and 7 illustrate this concept.

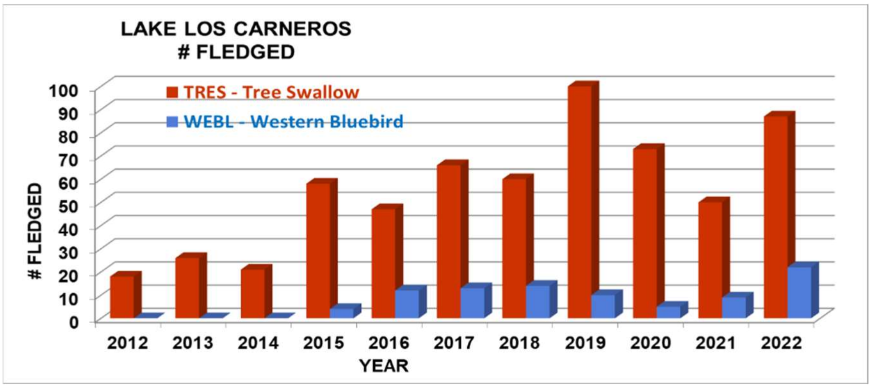


Fig. 6a Number of Fledged per Season/Year

Fig. 6a lets us see at a glance that we have a lot more TRES than WEBL fledging; but this could be because the WEBL have a much higher mortality rate (not true). Or it could be true that the TRES are using many more nest boxes than the WEBL (true).

So, let's normalize these data with respect to nest boxes and see how that changes things.

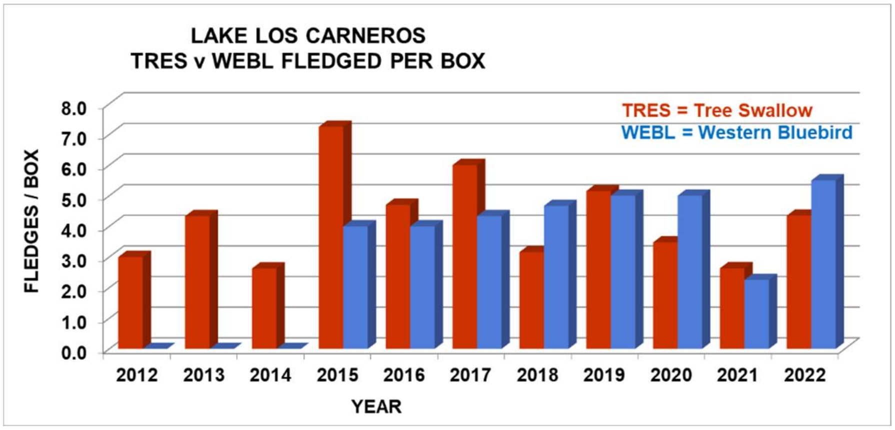


Fig. 6b Number of Fledged per Nest Box per Year

With the additional information that Fig. 6b provides, we see that the WEBL and TRES produce similar numbers of fledges per box and that the old system of boxes and locations (pre-2016) is roughly comparable to the results from the new systems (2016 and after); with only a slight, average improvement post-2015.

It reveals that the apparent improvement in fledges, with time, was mainly due to an increase in the number of nest boxes. The selective change of location of specific nest boxes also likely resulted in a higher fledging rate.

But, again, while this is true for the increase of fledged TRES; the increase in fledged WEBL could be from a number of reasons. For one, the increasing plethora of boxes available to the TRES may have reduced the TRES's aggressiveness in trying to keep the WEBL out of their territory.

There is still one factor that remains to be normalized to make this emerging picture more complete. The fact that the TRES tend to have two nesting attempts per box per season, and the WEBL tend to have only one, masks how relatively more effective the WEBL are at producing fledged birds. We could look at this with respect to eggs laid or to hatched nestlings. Let's look at both.

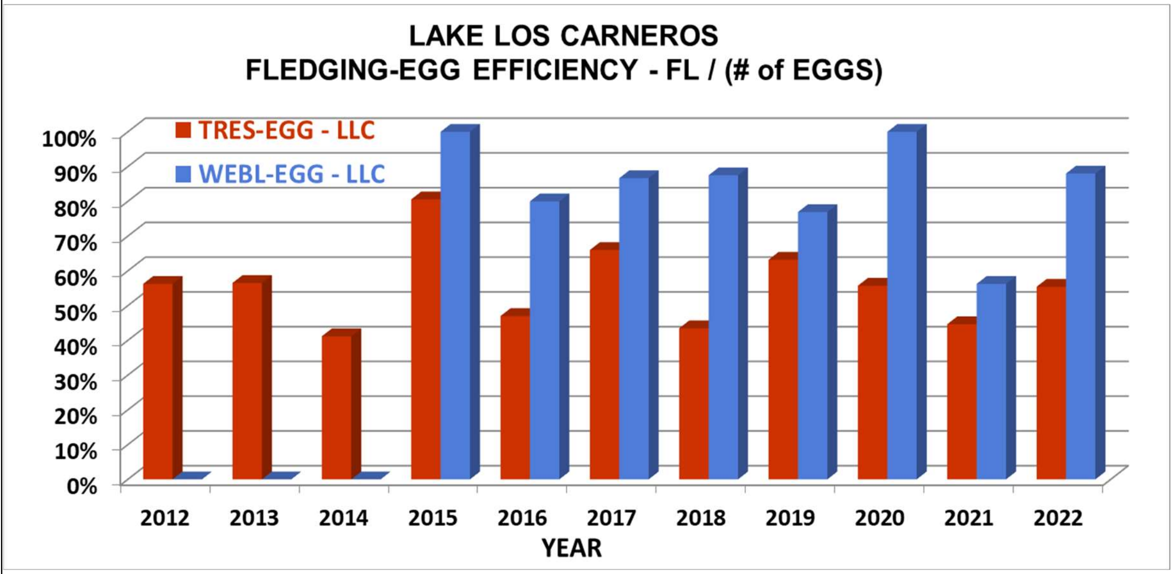


Fig. 6c Number of Fledged per Egg Laid per Year

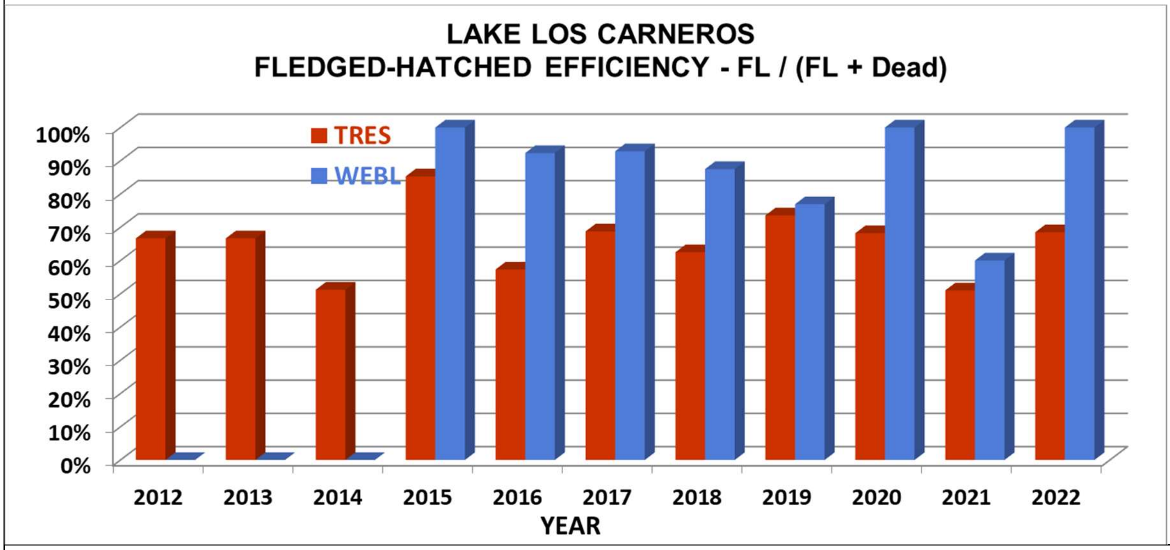


Fig. 6d Number of Fledged per Number Hatched per Year

Fig. 6c and 6d are very similar, even though egg mortality does vary from year to year (which is the basic difference between 6c and 6d), it is not as great a variable as is introduced with different numbers of boxes or variance in 2nd nests.

We somewhat arbitrarily chose the FEE (Fledged-Egg Efficiency) over the FHE (Fledged-Hatched Efficiency). While they both represent significant energy inputs from the birds and give similar results, the volunteers are more accurate in counting eggs than in counting the hatched nestlings jumbled together in a ball in the bottom of the nest (Fig. 6e and 6f).

Fig. 6e Eggs in Nest

Fig 6f Nestlings in Nest

The question comes as to why we do not include 'nest building' into the energy inputs. We considered that since both the TRES and WEBL may start and stop, 'change their minds' and go somewhere else, and generally 'dawdle' around with the nest building process, nest construction "cost" could not easily be quantified and attributed to specific individuals. Our observation is that, only when the eggs are laid, do they get 'serious' (defend their nest) about it all; so, at least for them, it would seem, when they have laid the first egg, they are committed to that nesting attempt.

One other interesting perspective is to look at FEE for the first and second nest cycles for both the TRES and WEBL. While having a second nest cycle is common with the TRES at LLC, it also occasionally occurs with the WEBL as well (2019 and 2022). Except for 2019, the TRES FEE is less for the second nest cycle and has been drastically less for the past three seasons, as shown in Fig. 6g. This is likely due to the drought conditions existing in the last few years.

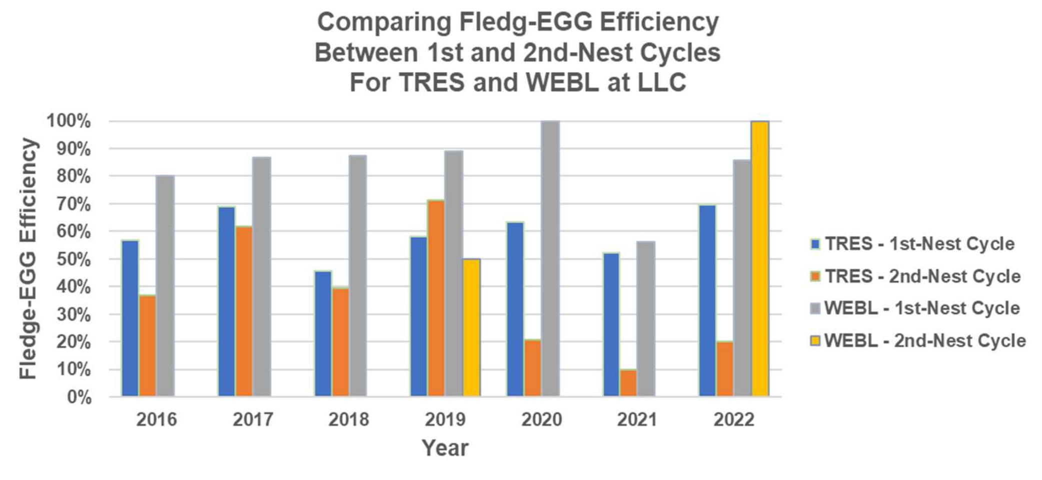


Fig. 6g FEE as a function Nest Cycle and Species

In summary, the **total numbers fledged** show that we have many more TRES than WEBL at LLC. The **number of fledged per box** shows that, generally, the TRES and WEBL produce similar numbers of fledges per box. And the **number of fledges per eggs laid** indicate that, at LLC, the WEBL are generally more efficient at producing fledges.

In summary, while the WEBL are more successful in converting an egg into a fledged bird, the TRES, because they often have second nests, produce more eggs; therefore, they have similar numbers of fledges per season/box.

Fig. 7 puts the four views together to make the comparisons clearer.

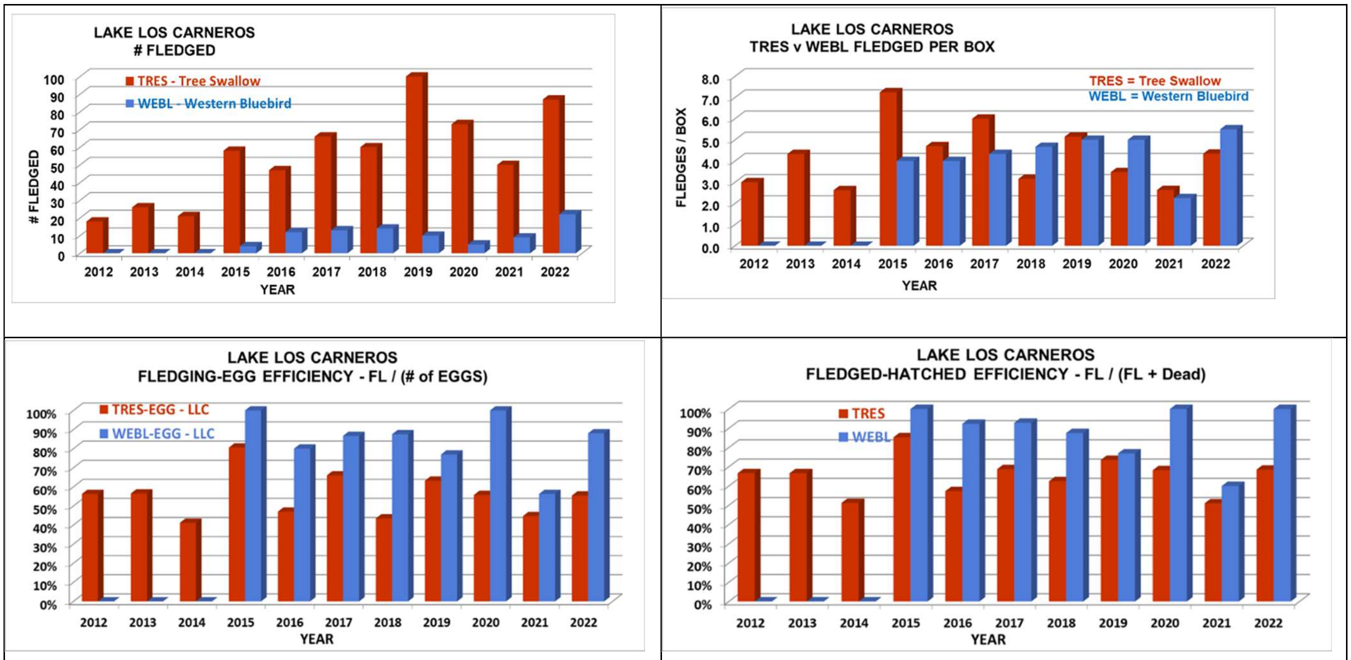


Fig. 7 Summary of the different Data Presentations

Finally, it is interesting to compare these three main data representations, or ***figures of merit***, with the results from COPR for the time period that we have data from COPR. As details such as nest box design and placement and monitoring protocols were relatively the same, differences in Fledges per Box and Fledging Egg Efficiency are likely attributable to differences in environment.

At first appearance, two differences in environment stand out. LLC has a relatively large, freshwater pond at its center; while COPR's waterbodies are more distributed, with many saline and brackish, except during and just after the rainy season; which corresponds with the nesting season – with the very notable addition that, in 2012 and 2013, the Ocean Meadows Golf Course (now North Campus Open Space - NCOS) was still being watered (a freshwater supply).

In Figs. 8a-f, the cessation of the watering of the golf course corresponds with a drop in the TRES viability at COPR – but does not seem to significantly affect the WEBL. Perhaps the WEBL are more tolerant of brackish water than the TRES or they get their fresh water requirement from the dew on the grass. Perhaps also, with the TRES weakened, the WEBL were better able to thrive. Still, overall, using FEE as the metric, both TRES and WEBL did worse at COPR than at LLC. (Except that, for some reason, there were no WEBL at LLC nest boxes from 2012 to 2014.)

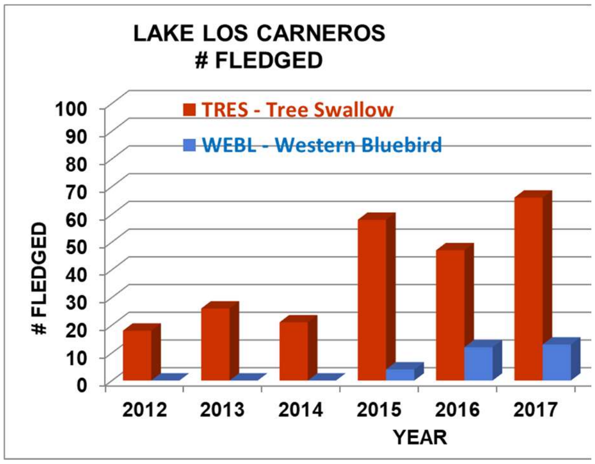


Fig. 8a LLC Fledged-Year 2012-2017

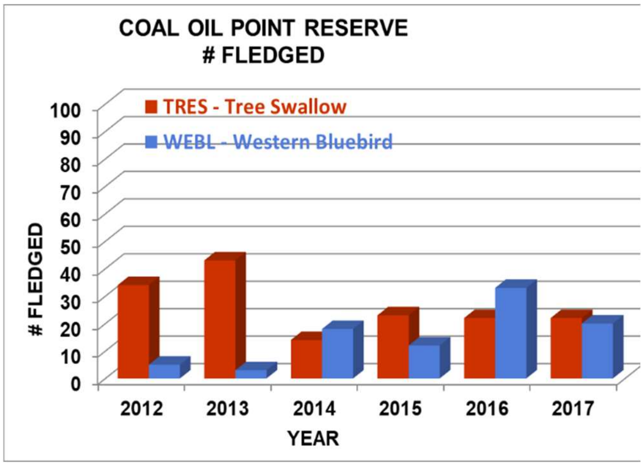


Fig. 8b COPR Fledged-Year 2012-2017

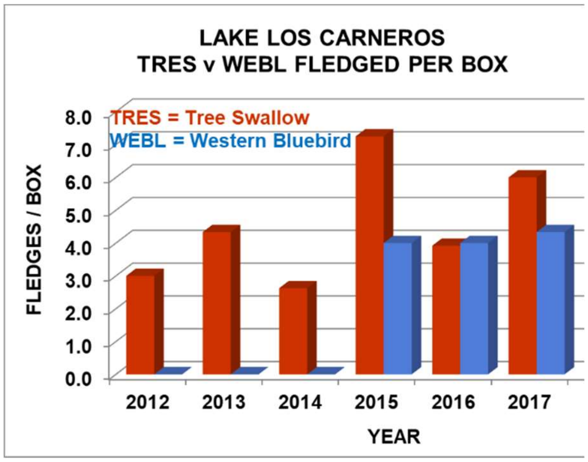


Fig. 8c LLC Fledged/Box 2012-2017

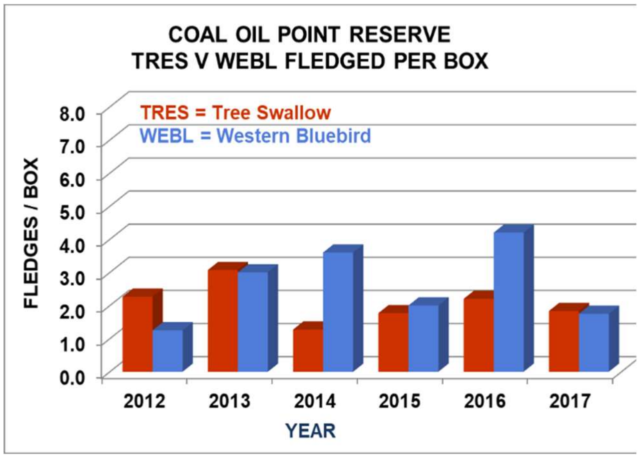


Fig. 8d COPR Fledged/Box 2012-2017

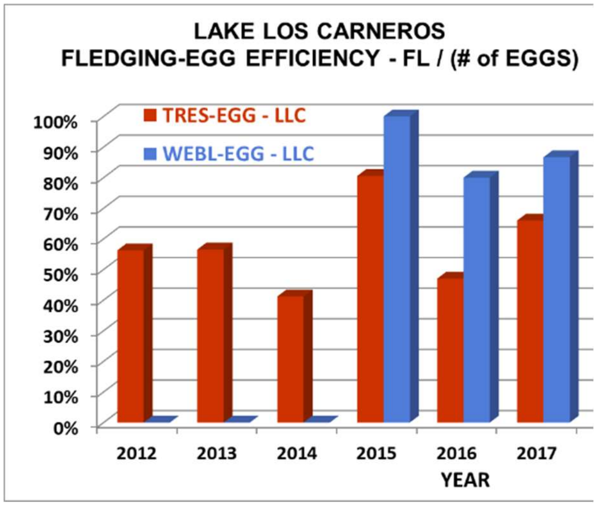


Fig. 8e LLC FEE -Year 2012-2017

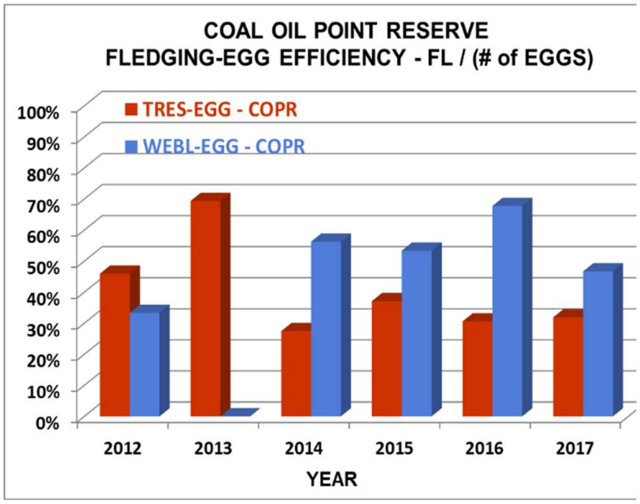
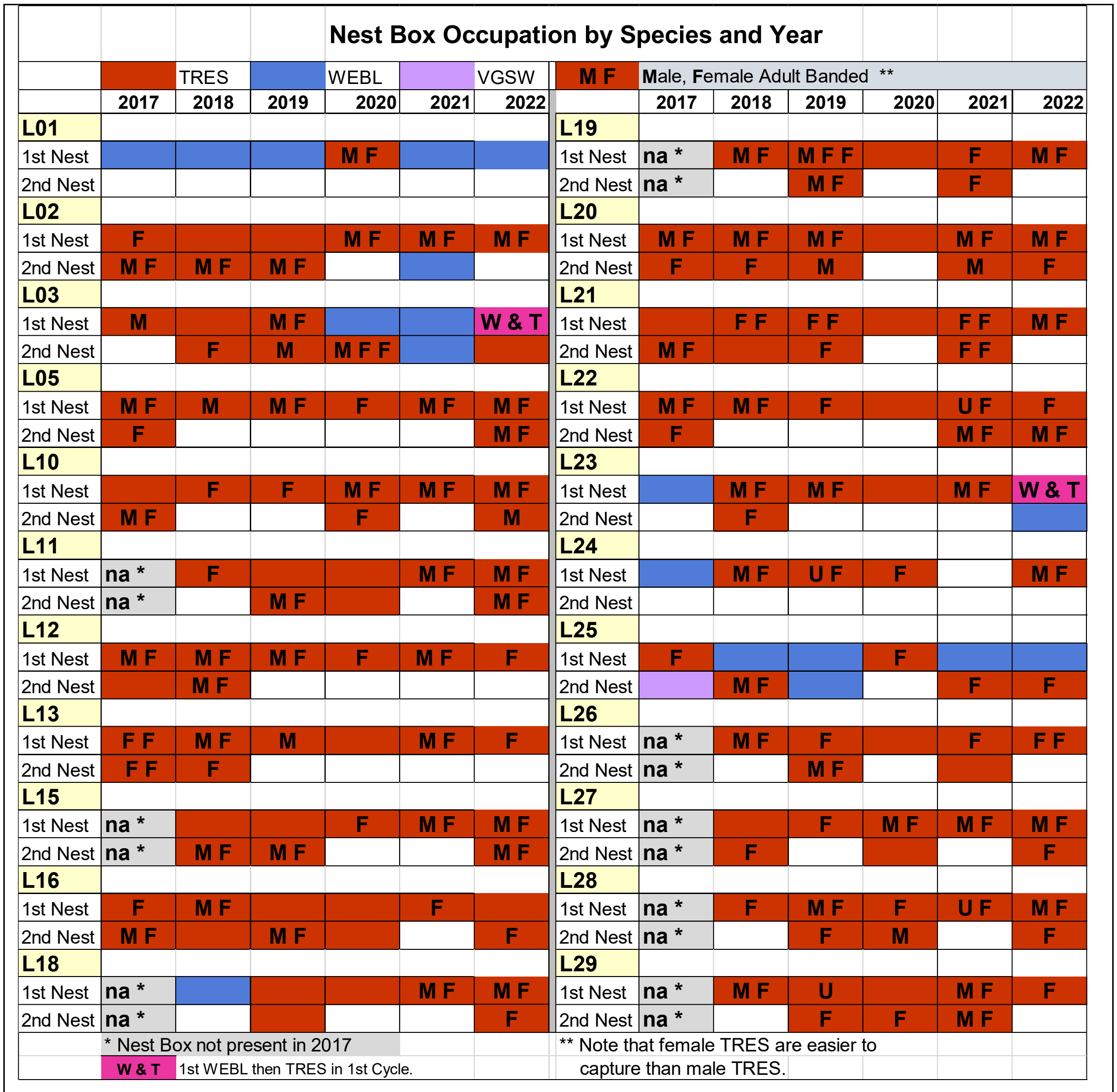


Fig. 8f COPR FEE -Year 2012-2017

An additional view of the nest box occupancy at LLC from 2017 to 2022 is shown in Fig. 9. It shows, by nest box, whether it was occupied, and if so, by which species. Where there are data, the sex(es) of the captured/banded adults are indicated. Note that in three instances there is an indication that there were two adult females associated with the same nest – L13, 1st and 2nd nest cycles, 2017; and L19, 2nd nest cycle, 2019. This is elaborated upon in Appendix 2.



Nest Box Occupation by Species and Year

🟥 TRES 🟦 WEBL 🟪 VGSW 🟥 M F Male, Female Adult Banded **

	2017	2018	2019	2020	2021	2022		2017	2018	2019	2020	2021	2022
L01							**L19**						
1st Nest	🟦	🟦	🟦	🟥 M F	🟦	🟦	1st Nest	na *	🟥 M F	🟥 M F F	🟥	🟥 F	🟥 M F
2nd Nest							2nd Nest	na *		🟥 M F		🟥 F	
L02							**L20**						
1st Nest	🟥 F	🟥	🟥	🟥 M F	🟥 M F	🟥 M F	1st Nest	🟥 M F	🟥 M F	🟥 M F	🟥	🟥 M F	🟥 M F
2nd Nest	🟥 M F	🟥 M F	🟥 M F		🟦		2nd Nest	🟥 F	🟥 F	🟥 M		🟥 M	🟥 F
L03							**L21**						
1st Nest	🟥 M	🟥	🟥 M F	🟦	🟦	W & T	1st Nest	🟥	🟥 F F	🟥 F F	🟥	🟥 F F	🟥 M F
2nd Nest		🟥 F	🟥 M	🟥 M F F	🟦	🟥	2nd Nest	🟥 M F	🟥	🟥 F		🟥 F F	
L05							**L22**						
1st Nest	🟥 M F	🟥 M	🟥 M F	🟥 F	🟥 M F	🟥 M F	1st Nest	🟥 M F	🟥 M F	🟥 F	🟥	🟥 U F	🟥 F
2nd Nest	🟥 F					🟥 M F	2nd Nest	🟥 F				🟥 M F	🟥 M F
L10							**L23**						
1st Nest	🟥	🟥 F	🟥 F	🟥 M F	🟥 M F	🟥 M F	1st Nest	🟦	🟥 M F	🟥 M F	🟥	🟥 M F	W & T
2nd Nest	🟥 M F			🟥 F		🟥 M	2nd Nest		🟥 F				🟦
L11							**L24**						
1st Nest	na *	🟥 F	🟥	🟥	🟥 M F	🟥 M F	1st Nest	🟦	🟥 M F	🟥 U F	🟥 F		🟥 M F
2nd Nest	na *		🟥 M F	🟥		🟥 M F	2nd Nest						
L12							**L25**						
1st Nest	🟥 M F	🟥 M F	🟥 M F	🟥 F	🟥 M F	🟥 F	1st Nest	🟥 F	🟦	🟦	🟥 F	🟦	🟦
2nd Nest	🟥	🟥 M F					2nd Nest	🟪	🟥 M F	🟦		🟥 F	🟥 F
L13							**L26**						
1st Nest	🟥 F F	🟥 M F	🟥 M	🟥	🟥 M F	🟥 F	1st Nest	na *	🟥 M F	🟥 F	🟥	🟥 F	🟥 F F
2nd Nest	🟥 F F	🟥 F					2nd Nest	na *		🟥 M F		🟥	
L15							**L27**						
1st Nest	na *	🟥	🟥	🟥 F	🟥 M F	🟥 M F	1st Nest	na *	🟥	🟥 F	🟥 M F	🟥 M F	🟥 M F
2nd Nest	na *	🟥 M F	🟥 M F			🟥 M F	2nd Nest	na *	🟥 F		🟥		🟥 F
L16							**L28**						
1st Nest	🟥 F	🟥 M F	🟥	🟥	🟥 F	🟥	1st Nest	na *	🟥 F	🟥 M F	🟥 F	🟥 U F	🟥 M F
2nd Nest	🟥 M F	🟥	🟥 M F	🟥		🟥 F	2nd Nest	na *		🟥 F	🟥 M		🟥 F
L18							**L29**						
1st Nest	na *	🟦	🟥	🟥	🟥 M F	🟥 M F	1st Nest	na *	🟥 M F	🟥 U	🟥	🟥 M F	🟥 F
2nd Nest	na *		🟥			🟥 F	2nd Nest	na *		🟥 F	🟥 F	🟥 M F	

* Nest Box not present in 2017

W & T 1st WEBL then TRES in 1st Cycle.

** Note that female TRES are easier to capture than male TRES.

Fig. 9 Nest Box Occupancy Chart

Temporal Results

With the temporal results we have the possibility to see the effects of climate change on the populations of TRES and WEBL. Presumably, with warmer, year-round weather, the birds will begin nesting earlier and earlier. However, issues like drought and different food sources arriving or disappearing, different parasites, etc. could also affect the ecological equation for the TRES and WEBL. In our limited timeframe, this ‘noise’ masks what effects there may be.

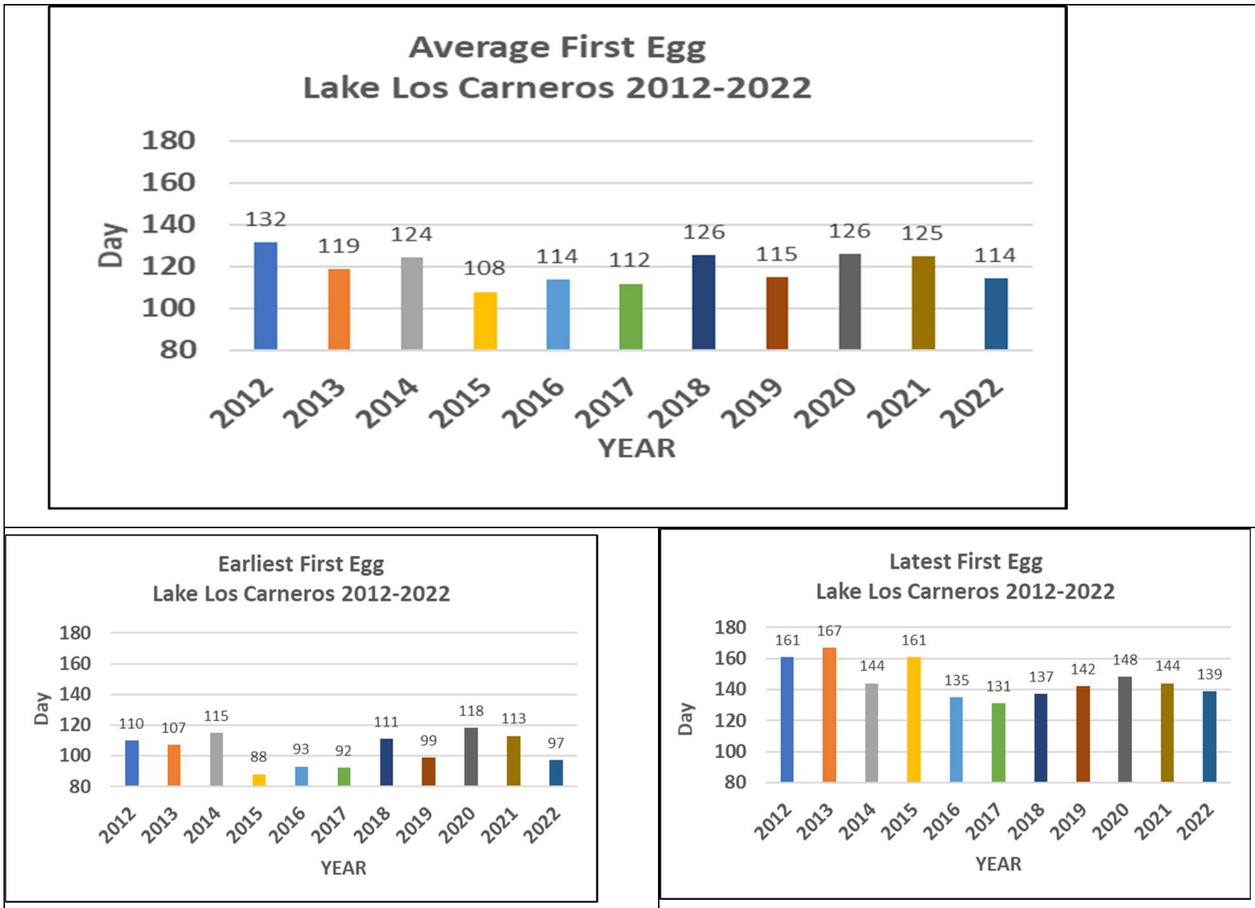


Fig. 10 Temporal Results for TRES

Again, we are taking the ‘first egg’ rather than the ‘first fiber’ (of the nest) as the indicator because our observation is that, with the first egg, the TRES become seriously interested in defending the nest; or, in other words, really ‘commit’ to the nest.

In summary, for TRES, for the years 2012 to 2022:

The average 1st egg is on the 120th day (30th of April)

The average ‘earliest’ first egg is on the 105th day (15th of April)

The average ‘latest’ first egg in on the 147th day (27th of May)

The absolute earliest first egg was the 88th day (29th of March)

Natural History Representation – How individuals and populations interact with each other and their environment.

In 2017, Dr. Don Schroeder began banding the TRES and WEBL at the LLC nest boxes, with the assistance of Elaine Tan and various teams of volunteers.

By attaching a shutter to the front of the box; controlled by a long string, we could close the shutter over the hole when an adult went into the box to feed the nestlings. To remove the captured adult, we slid a cardboard in-between the lid and the body of the box, then lifting the lid, we placed a foam rectangle over the cardboard (with a hole in its center for our hand to fit through), then, blocking the hole with our hand, we slid the cardboard out, and reached into the box, locating the adult by touch (generally hiding in a corner), and, gently wrapped it up in our fingers, removed it from the box, placed it into a roomy cloth bag, and closed the bag with a clamp or tie. We then reset the box and shutter to attempt to also capture its mate; while keeping the captured bird quietly in the shade.

Generally, it was more difficult to capture the second bird (often the male of the pair); so, after 10 or 15 minutes, regardless, we would collect the nestlings into another bag and bring them all to the banding table to be weighed and banded (if not already banded), and their data recorded.

Once the nestlings were placed back into the nest box, the captured adult(s) were released.

A potential, confounding factor here is the possibility that adult captures at a "disturbed" box may have a higher rate of floaters entering the box. See Appendix 2 for a discussion of "floaters." For example, situations where the box does not have to be lowered (to attach the shutter-string) may have a lower rate of floater intrusion. This is unlikely as adults entering a minimally disturbed box are likely to be committed to the nesting by bringing food to the nestlngs – floaters, unless they are helpers, would be expected to enter the box to engage in behaviors to afford taking over the nest.

Greater box disturbance, such as during and after removal of adults and/or nestlings, may afford an increased likelihood of floater capture.

A potential future study using RFID tags may allow comparison of visitation schedules (including both tagged and non-tagged individuals) during periods of box disturbance vs periods without disturbance.

There are various ways the banding data can be presented. We have presented a fraction of it here to just track potential patterns of how the birds choose mates and boxes, to get some indications about how many of them return to LLC each year, and to which boxes; as well, some indication of how long they live in the wild - Average Wild Lifespan (AWLS).

Further, we created a Sustainability Index (SI) to indicate how sustainable the TRES population is at LLC. We do not believe we have enough WEBL data to make any significant evaluation of their sustainability at this time.

Fig. 11 is a record of individual birds, with whom they have mated, and which nest boxes they have used over the years. By seeing how long they have been coming, we can make a conservative estimate their age. We say "conservative" because, while they may have stopped coming because they have died, they may only appear to have stopped coming because we were unable to subsequently capture them, or they were pressured by more aggressive birds (or better opportunity) to nest elsewhere, or not at all; but they still lived on.

Cell designation definitions for Fig. 11 – Tracking Individual TRES over Time.

Each cell entry is of the format: Box # - Age, Date of Capture. For example:

L02-AHY 27Apr (in the 2017 column) means:

Box = **L02**; Age = **AHY** (After Hatch Year); Date of Capture = **27 Apr** 2017

Age Definitions

L – It is a nestling being banded.

SY – Second Year (it was either already banded the previous year or we can tell from the brownish plumage that it is a second-year female.)

TY – Third Year (Again, we know it was banded as a nestling and when.)

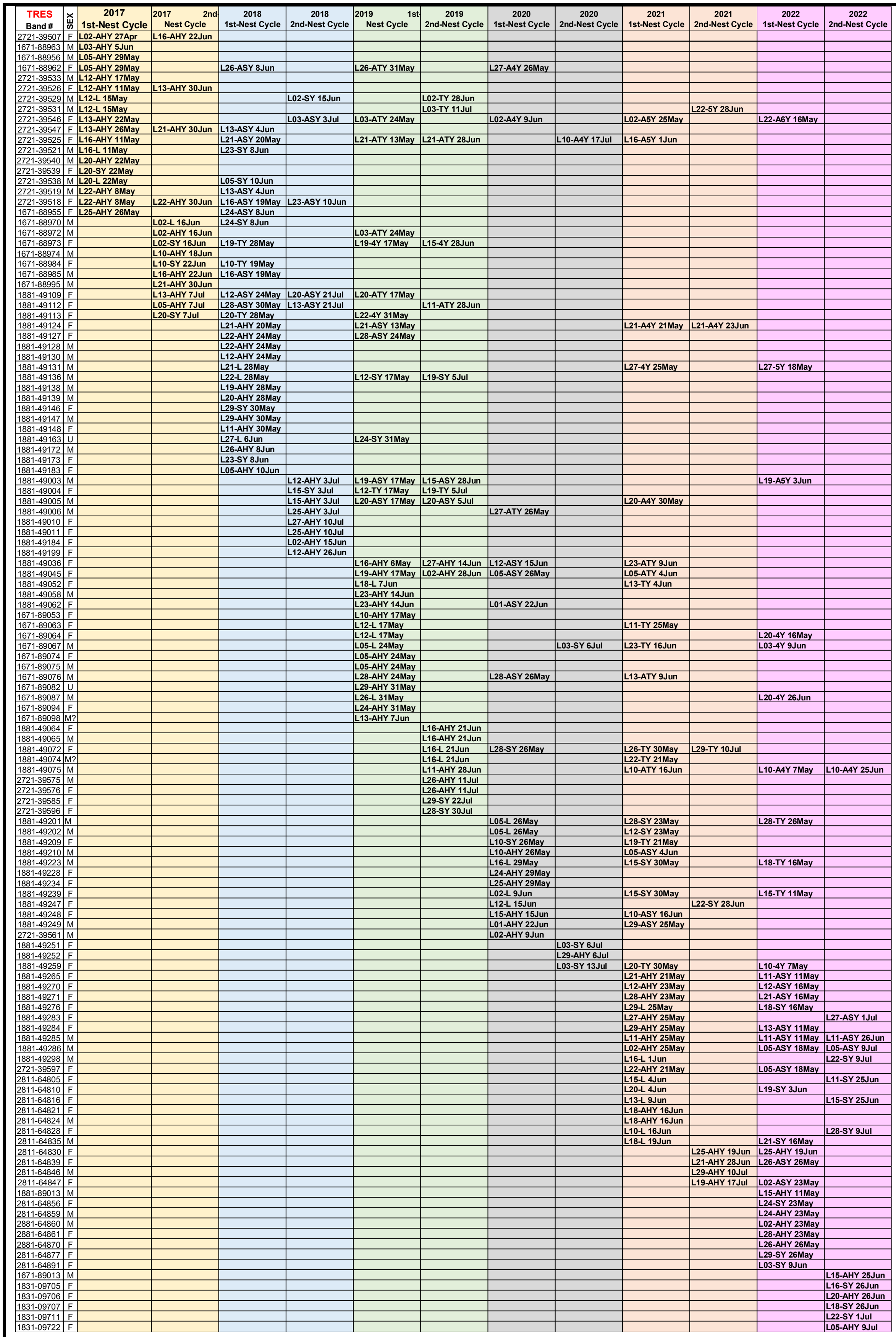
4Y – Fourth Year (and so on): 5Y, 6Y, …

AHY – After Hatch Year (It was older than one year when first captured and banded.)

ASY – After Second Year (It was AHY the previous year)

ATY – After Third Year (it was ASY the previous year) (and so on)

As one can see in Fig. 11, there are many branching’s in the data as the individual birds frequently, over the years, change nest boxes and mates, making it difficult to track who has mated with whom and when. Appendix 1 presents a methodology for doing this.



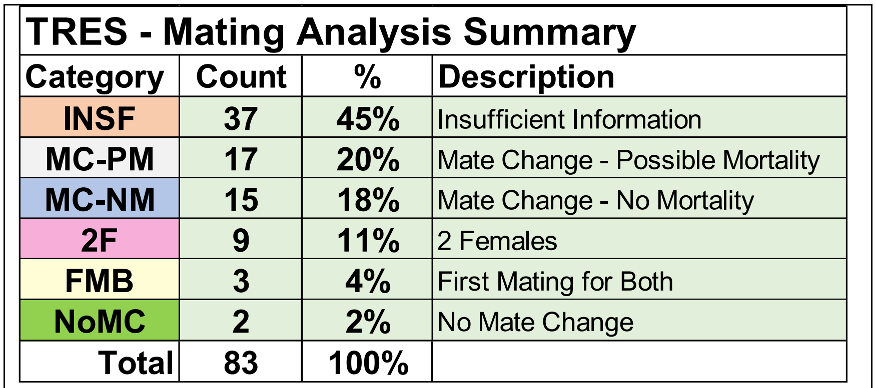
TRES Band #	SEX	2017 1st-Nest Cycle	2017 2nd-Nest Cycle	2018 1st-Nest Cycle	2018 2nd-Nest Cycle	2019 1st-Nest Cycle	2019 2nd-Nest Cycle	2020 1st-Nest Cycle	2020 2nd-Nest Cycle	2021 1st-Nest Cycle	2021 2nd-Nest Cycle	2022 1st-Nest Cycle	2022 2nd-Nest Cycle
2721-39507	F	L02-AHY 27Apr	L16-AHY 22Jun										
1671-88963	M	L03-AHY 5Jun											
1671-88956	M	L05-AHY 29May											
1671-88962	F	L05-AHY 29May		L26-ASY 8Jun		L26-ATY 31May		L27-A4Y 26May					
2721-39533	M	L12-AHY 17May											
2721-39526	F	L12-AHY 11May	L13-AHY 30Jun										
2721-39529	M	L12-L 15May			L02-SY 15Jun		L02-TY 28Jun						
2721-39531	M	L12-L 15May					L03-TY 11Jul				L22-5Y 28Jun		
2721-39546	F	L13-AHY 22May			L03-ASY 3Jul	L03-ATY 24May		L02-A4Y 9Jun		L02-A5Y 25May		L22-A6Y 16May	
2721-39547	F	L13-AHY 26May	L21-AHY 30Jun	L13-ASY 4Jun									
2721-39525	F	L16-AHY 11May		L21-ASY 20May		L21-ATY 13May	L21-ATY 28Jun		L10-A4Y 17Jul	L16-A5Y 1Jun			
2721-39521	M	L16-L 11May		L23-SY 8Jun									
2721-39540	M	L20-AHY 22May											
2721-39539	F	L20-SY 22May											
2721-39538	M	L20-L 22May		L05-SY 10Jun									
2721-39519	M	L22-AHY 8May		L13-ASY 4Jun									
2721-39518	F	L22-AHY 8May	L22-AHY 30Jun	L16-ASY 19May	L23-ASY 10Jun								
1671-88955	F	L25-AHY 26May		L24-ASY 8Jun									
1671-88970	M		L02-L 16Jun	L24-SY 8Jun									
1671-88972	M		L02-AHY 16Jun			L03-ATY 24May							
1671-88973	F		L02-SY 16Jun	L19-TY 28May		L19-4Y 17May	L15-4Y 28Jun						
1671-88974	M		L10-AHY 18Jun										
1671-88984	F		L10-SY 22Jun	L10-TY 19May									
1671-88985	M		L16-AHY 22Jun	L16-ASY 19May									
1671-88995	M		L21-AHY 30Jun										
1881-49109	F		L13-AHY 7Jul	L12-ASY 24May	L20-ASY 21Jul	L20-ATY 17May							
1881-49112	F		L05-AHY 7Jul	L28-ASY 30May	L13-ASY 21Jul		L11-ATY 28Jun						
1881-49113	F		L20-SY 7Jul	L20-TY 28May		L22-4Y 31May							
1881-49124	F			L21-AHY 20May		L21-ASY 13May				L21-A4Y 21May	L21-A4Y 23Jun		
1881-49127	F			L22-AHY 24May		L28-ASY 24May							
1881-49128	M			L22-AHY 24May									
1881-49130	M			L12-AHY 24May									
1881-49131	M			L21-L 28May						L27-4Y 25May		L27-5Y 18May	
1881-49136	M			L22-L 28May		L12-SY 17May	L19-SY 5Jul						
1881-49138	M			L19-AHY 28May									
1881-49139	M			L20-AHY 28May									
1881-49146	F			L29-SY 30May									
1881-49147	M			L29-AHY 30May									
1881-49148	F			L11-AHY 30May									
1881-49163	U			L27-L 6Jun		L24-SY 31May							
1881-49172	M			L26-AHY 8Jun									
1881-49173	F			L23-SY 8Jun									
1881-49183	F			L05-AHY 10Jun									
1881-49003	M				L12-AHY 3Jul	L19-ASY 17May	L15-ASY 28Jun					L19-A5Y 3Jun	
1881-49004	F				L15-SY 3Jul	L12-TY 17May	L19-TY 5Jul						
1881-49005	M				L15-AHY 3Jul	L20-ASY 17May	L20-ASY 5Jul			L20-A4Y 30May			
1881-49006	M				L25-AHY 3Jul			L27-ATY 26May					
1881-49010	F				L27-AHY 10Jul								
1881-49011	F				L25-AHY 10Jul								
1881-49184	F				L02-AHY 15Jun								
1881-49199	F				L12-AHY 26Jun								
1881-49036	F					L16-AHY 6May	L27-AHY 14Jun	L12-ASY 15Jun		L23-ATY 9Jun			
1881-49045	F					L19-AHY 17May	L02-AHY 28Jun	L05-ASY 26May		L05-ATY 4Jun			
1881-49052	F					L18-L 7Jun				L13-TY 4Jun			
1881-49058	M					L23-AHY 14Jun							
1881-49062	F					L23-AHY 14Jun		L01-ASY 22Jun					
1671-89053	F					L10-AHY 17May							
1671-89063	F					L12-L 17May				L11-TY 25May			
1671-89064	F					L12-L 17May						L20-4Y 16May	
1671-89067	M					L05-L 24May			L03-SY 6Jul	L23-TY 16Jun		L03-4Y 9Jun	
1671-89074	F					L05-AHY 24May							
1671-89075	M					L05-AHY 24May							
1671-89076	M					L28-AHY 24May		L28-ASY 26May		L13-ATY 9Jun			
1671-89082	U					L29-AHY 31May							
1671-89087	M					L26-L 31May						L20-4Y 26Jun	
1671-89094	F					L24-AHY 31May							
1671-89098	M?					L13-AHY 7Jun							
1881-49064	F						L16-AHY 21Jun						
1881-49065	M						L16-AHY 21Jun						
1881-49072	F						L16-L 21Jun	L28-SY 26May		L26-TY 30May	L29-TY 10Jul		
1881-49074	M?						L16-L 21Jun			L22-TY 21May			
1881-49075	M						L11-AHY 28Jun			L10-ATY 16Jun		L10-A4Y 7May	L10-A4Y 25Jun
2721-39575	M						L26-AHY 11Jul						
2721-39576	F						L26-AHY 11Jul						
2721-39585	F						L29-SY 22Jul						
2721-39596	F						L28-SY 30Jul						
1881-49201	M							L05-L 26May		L28-SY 23May		L28-TY 26May	
1881-49202	M							L05-L 26May		L12-SY 23May			
1881-49209	F							L10-SY 26May		L19-TY 21May			
1881-49210	M							L10-AHY 26May		L05-ASY 4Jun			
1881-49223	M							L16-L 29May		L15-SY 30May		L18-TY 16May	
1881-49228	F							L24-AHY 29May					
1881-49234	F							L25-AHY 29May					
1881-49239	F							L02-L 9Jun		L15-SY 30May		L15-TY 11May	
1881-49247	F							L12-L 15Jun			L22-SY 28Jun		
1881-49248	F							L15-AHY 15Jun		L10-ASY 16Jun			
1881-49249	M							L01-AHY 22Jun		L29-ASY 25May			
2721-39561	M							L02-AHY 9Jun					
1881-49251	F								L03-SY 6Jul				
1881-49252	F								L29-AHY 6Jul				
1881-49259	F								L03-SY 13Jul	L20-TY 30May		L10-4Y 7May	
1881-49265	F									L21-AHY 21May		L11-ASY 11May	
1881-49270	F									L12-AHY 23May		L12-ASY 16May	
1881-49271	F									L28-AHY 23May		L21-ASY 16May	
1881-49276	F									L29-L 25May		L18-SY 16May	
1881-49283	F									L27-AHY 25May			L27-ASY 1Jul
1881-49284	F									L29-AHY 25May		L13-ASY 11May	
1881-49285	M									L11-AHY 25May		L11-ASY 11May	L11-ASY 26Jun
1881-49286	M									L02-AHY 25May		L05-ASY 18May	L05-ASY 9Jul
1881-49298	M									L16-L 1Jun			L22-SY 9Jul
2721-39597	F									L22-AHY 21May		L05-ASY 18May	
2811-64805	F									L15-L 4Jun			L11-SY 25Jun
2811-64810	F									L20-L 4Jun		L19-SY 3Jun	
2811-64816	F									L13-L 9Jun			L15-SY 25Jun
2811-64821	F									L18-AHY 16Jun			
2811-64824	M									L18-AHY 16Jun			
2811-64828	F									L10-L 16Jun			L28-SY 9Jul
2811-64835	M									L18-L 19Jun		L21-SY 16May	
2811-64830	F										L25-AHY 19Jun	L25-AHY 19Jun	
2811-64839	F										L21-AHY 28Jun	L26-ASY 26May	
2811-64846	M										L29-AHY 10Jul		
2811-64847	F										L19-AHY 17Jul	L02-ASY 23May	
1881-89013	M											L15-AHY 11May	
2811-64856	F											L24-SY 23May	
2811-64859	M											L24-AHY 23May	
2881-64860	M											L02-AHY 23May	
2881-64861	F											L28-AHY 23May	
2881-64870	F											L26-AHY 26May	
2811-64877	F											L29-SY 26May	
2811-64891	F											L03-SY 9Jun	
1671-89013	M												L15-AHY 25Jun
1831-09705	F												L16-SY 26Jun
1831-09706	F												L20-AHY 26Jun
1831-09707	F												L18-SY 26Jun
1831-09711	F												L22-SY 1Jul
1831-09722	F												L05-AHY 9Jul

Fig. 11 Chart Tracking Individual TRES Over Time

When both adults are captured at a nest box during a specific nesting cycle, it allows us determine the mating pair with some degree of certainty. With this information, and for a number of nesting cycles, we can discover whether they tend to keep the same mates and whether they tend to return to the same nest boxes.

We divided the possible results into six categories:

1. **FMB** = First Mating for Both
2. **NoMC** = No Mate Change
3. **MC-NM** = Mate Change, No Mortality – they changed to a different mate while their previous mate was still alive in the vicinity.
4. **MC-PM** = Mate Change, Possible Mortality – they changed mates and there is no current or future record of their previous mate.
5. **INSF** = Insufficient information to determine the status to a great likelihood.
6. **2F** = Two Females – there were two females associated with the box, but only one set of eggs. In one case, this occurred for several years with one particular female; i.e., there probably was not a ‘floater’, as in ‘intruder’, involved. (see Appendix 2 for details)

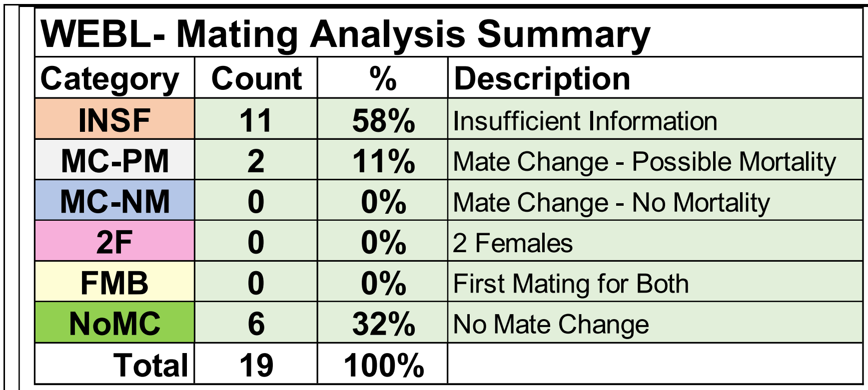


TRES - Mating Analysis Summary

Category	Count	%	Description
INSF	37	45%	Insufficient Information
MC-PM	17	20%	Mate Change - Possible Mortality
MC-NM	15	18%	Mate Change - No Mortality
2F	9	11%	2 Females
FMB	3	4%	First Mating for Both
NoMC	2	2%	No Mate Change
Total	83	100%	

Fig. AP1v TRES Mating Pair Classification Summary

For the TRES, NoMC (No Mate Change) has the lowest percentage of all the possible categories and MC-NM is the third highest. This indicates that ***TRES are quite fluid in terms of choosing mates***.



WEBL- Mating Analysis Summary

Category	Count	%	Description
INSF	11	58%	Insufficient Information
MC-PM	2	11%	Mate Change - Possible Mortality
MC-NM	0	0%	Mate Change - No Mortality
2F	0	0%	2 Females
FMB	0	0%	First Mating for Both
NoMC	6	32%	No Mate Change
Total	19	100%	

Fig. AP1w WEBL Mating Analysis Summary

For the WEBL, NoMC has the highest percentage, except for INSF (Insufficient Information) and MC-NM the lowest. This indicates that ***WEBL tend to keep the same mate over the years***.

The major qualification to these results would be the prevalence of ‘floaters’ (an adult bird temporarily occupying the nest box while the mated pair is away or during periods of major disturbance) confusing our data and this is dealt with in Appendix 2 – which is to say that ‘floaters’ may be an issue; but probably not a big enough one to greatly modify the trends we observed.

WEBLs also tend to return to the same box year after year; although this is somewhat masked by competition from TRES for particular boxes and limited data.

Most TRES do not seem to have an affinity for particular boxes; although some seem to.

The above is detailed in Appendix 1.

Sustainability Index - TRES

With all of the above data, we wondered if it would be possible to detect whether the TRES population was remaining stable. In other words, was it sustainable in our local environment.

In order for a population, in some specified region, to be sustainable, over some significant time-period, the additions to the population need to be greater than or equal to the losses.

To determine this, we need to know the species average lifespan and how many offspring survive to breed.

From the banding data, we can follow a fledgling over the years and say that it lived at least that number of years (acknowledging that it may have decided to nest elsewhere rather than having died or be an undetected floater).

However, most of the adult birds we capture are either designed AHY (After Hatch Year) or are a recapture of a bird originally designated AHY, i.e. ASY, ATY, A4Y, etc. For example, in 2021, 54% of the captured adults fell into one of these ‘Axx’ categories.

There are two significant issues with this: First, determining a likely age to assign to an AHY-bird. And second, that an AHY-bird, especially after a few years of banding nearly all of the nestlings, is very likely coming from elsewhere than Lake Los Carneros.

In order to estimate the **Average Wild Life Span (AWLS)**, we need to work out a ***reasonable*** average age for the “AHY” birds. This is an iterative process detailed in Appendix 3.

We determined that three years is the most reasonable average age for the AHY birds and this results in an estimate of **AWLS = 3.5 years for the TRES**. We feel that, given our methodology, that this is close to the lower bound of the reality.

So, reformulating the sustainability question: ***Do we have enough TRES fledglings returning in 3.5 years to reconstitute the population?***

So, now the question is: What do we mean by ***population***?

For this sustainability question, we are defining population to be the number of ***parents present in the <u>previous</u> season***. Regardless of whether they had two nests or one, they are counted only once.

And we are only counting the fledglings from the previous season that have ***returned in the <u>present</u> season*** – in other words, ones that attained breeding age.

Dividing the (Returned Fledglings) by (the Number of Parents Involved) gives us a kind of efficiency ratio that, when multiplied by the AWLS gives us a number that, if equal to or greater than one, means that the population is stable or growing. And if it is less than one, then the population in unsustainable (by its own regeneration; although, because there is seemingly a large source of TRES (from the Pacific Flyway) feeding our area, LLC may appear sustainable for many years. See Appendices 5 and 6 to observe the TRES migration pattern.

So, as is shown in greater detail in Appendix 3, for LLC, over the years of our study, the ***TRES Sustainability Index (SI) averages to be 0.5 – or <u>unsustainable</u>.***

SI - 2018 to 2022	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**SI Ave.**
AHY = 3 : AWLS = 3.5	na*	**0.6**	**0.3**	**0.3**	**0.6**	**0.7**	**0.5**
	* need to know # of parents from the previous year						

Fig. 12 Sustainability Index for TRES at LLC for the period 2018 to 2022

Some of the variations from year-to-year are likely due to significant variations in the TRES's environment; but some of it may be due to the relatively small sample sizes, where small, somewhat random events can have larger consequences.

Unfortunately, we have too little data to say much on the sustainability of the WEBL population.

A Larger Context

In the larger picture, our tiny nest box project is an insignificant dot. The TRES range across the United States and migrate from the South of Mexico to the edge of the Arctic Circle. The main, Western migration route goes through the San Joaquin Valley and the Santa Barbara region is only a backwater to that. From Appendix 5:

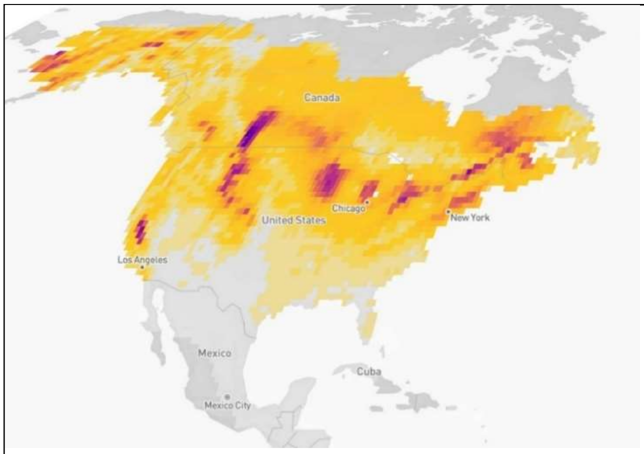


Fig. AP5a TRES Maximum Northern Extent

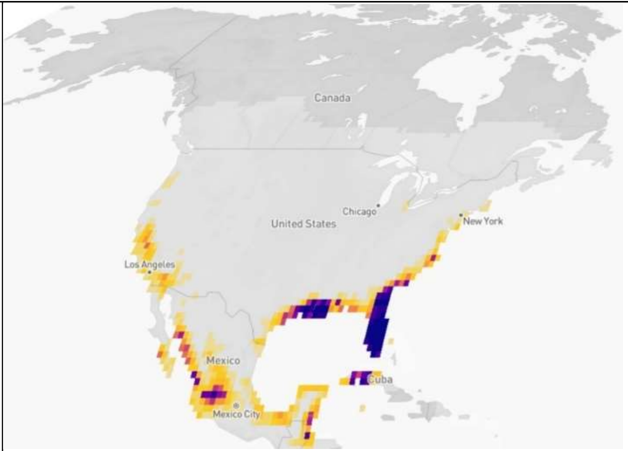


Fig. AP5b TRES Maximum Southern Extent

Recognizing that, in general, birds may be useful indicator species because they are both relatively intelligent and highly mobile, they can more rapidly adjust to changes in their environment.

It is conceivable that, as individuals, they are evaluating effort vs gain. Inflow of birds shown in Fig. AP5a, one sees higher concentrations of birds surrounded by lesser concentrations. One can assume the higher concentrations have better habitat; but also greater competition for that prime real estate; thus there is a diffusion of birds in between the higher concentrations, balancing effort vs gain. One can imagine that there is some kind of dynamic feedback system in place that allows for adjustments due to changing environmental conditions.

Thus, in the case of the Santa Barbara region, even though it seems that we may not have sustainable conditions for the TRES population, diffusion from the main stream of birds in the Pacific Flyway may be rather easily replenishing the losses. This could be one explanation for the relatively high percentage of AHY-birds that we are seeing. The are simply out-competing some of the otherwise local birds for the prime habitat nest box.

It would be interesting if someone would replicate our program along this main migratory pathway; perhaps at UC Davis.

The WEBL do not migrate, per se, but rather, expand and contract a bit; or manifest some hybrid combination of the two. From Appendix 5:

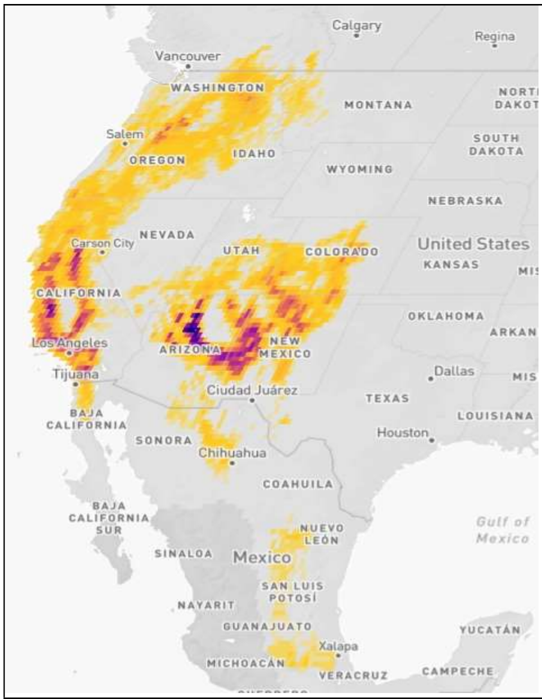


Fig. AP5c WEBL Maximum Extent

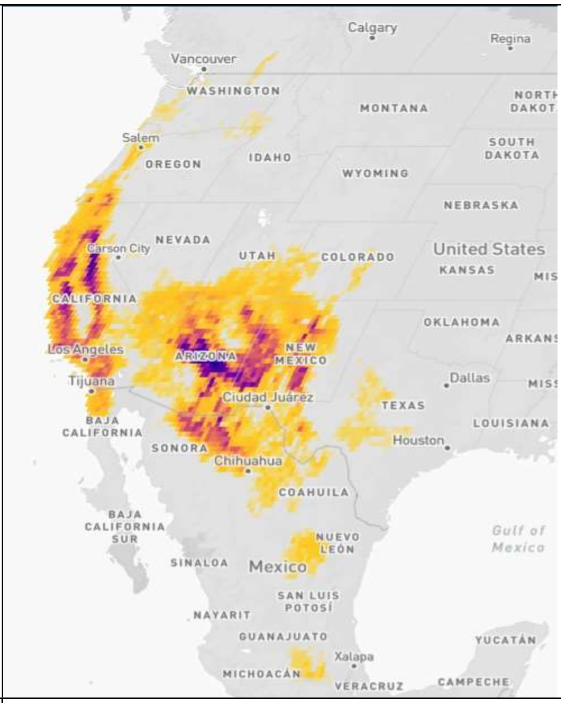


Fig. AP5c WEBL Minimum Extent

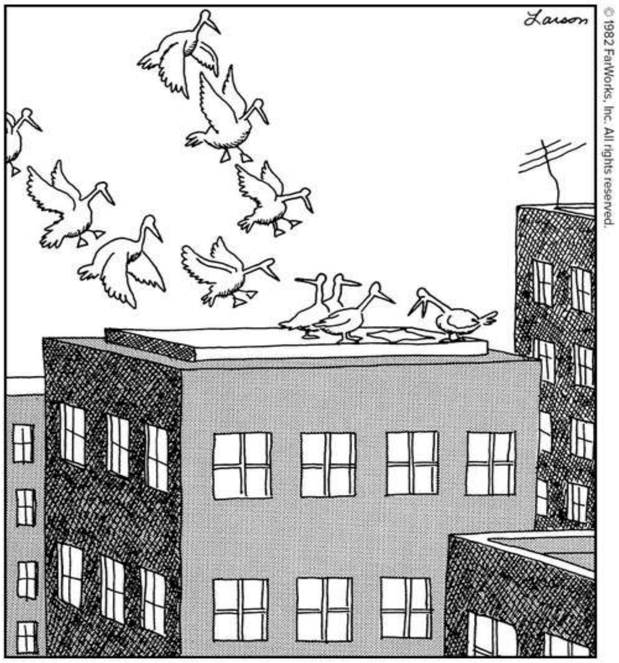
In our experience, the TRES essentially disappear from LLC by the end of August and begin to reappear toward the end of December to mid-January; whereas we see the WEBL year-round. It is interesting to note, that even though there is another banding project five miles away at the Laguna Blanca Country Club, ***we have never captured, or seen, any of their banded birds at LLC***.

It would seem that the TRES and WEBL have two, relatively quite different, evolutionary approaches to life. The TRES are a more adventurous, exploratory species and the WEBL a more conservative one. It would be interesting to track how well they do, given the environmental changes that appear to be coming due to climate change – how these seemingly different strategies affect their ability to adapt.

It is also interesting to note that TRES, while nominally being a colonial species like other swallows, are definitely territorial when they nest. Whether this is triggered by some hormonal change (triggered by what?), we do not know. But we do have the issue of the "AHY" birds showing up each year and establishing their nests. Again, it is interesting to speculate as to what is going on.

Perhaps, while in the South and being colonial, they form into groups of 'friends'. Then, when comes time to migrate North, some of the LLC-birds follow their 'new friends' back to where their new friends had been the previous season; and, in some cases, the 'new friends' follow the LLC-birds back to LLC. In other words, ***death may not be the only cause of the local attrition that we see; but rather regroupings of social groups, similar to what we see with their mating behavior***.

If the above has some truth, then our sustainability index is still valid for LLC, for whether the birds have left for 'greener pastures' or because they have died, they are still gone. This 'zero-sum approach is mentioned in Appendix 3.If the technology were there, it would be truly interesting to outfit several thousand TRES with little GPS units and track them over the course of several years – here, Mexico, and in California's Central Valley.



"For crying out loud! ... We were supposed to turn south after that last mountain range!"

Summary and Conclusions

Different ***figures of merit*** illuminate different facets of the TRES and WEBL's existence and environment.

> **Numbers Fledged** gives a macro comparison of the relative numbers of TRES and WEBL at Lake Los Carneros, Goleta, California.
>
> **Numbers Fledged per Box** allows one to determine the effectiveness of different nest boxes in producing fledges and compare this for TRES and WEBL. As it normalizes data with respect to number of nest boxes, fledging results from one program can be compared with the results from another program with a different number of nest boxes – or within one program where the number of nest boxes changes from year-to-year.
>
> **Fledging Efficiency** gives an insight into the respective mechanisms of the WEBL and TRES reproductive processes and the overall result.
>
> **AWLS** (Average Wild Lifespan) is an important reference for giving a context to the above figures of merit. It is also a critical component of the SI (below).
>
> **SI** (Sustainability Index) provides a normalized evaluation of the above to give an indication of whether a population is decreasing or thriving in a given area – in our case, at LLC.

When we combine these, the pictures they (crudely) paint of the TRES and WEBL show the TRES as generally changing mates each season, with a propensity of having two nest-cycles per season; while the WEBL are more monogamous and generally have only one nest per season.

From Numbers Fledged per Box, we see that, in the end, they produce similar numbers of fledges per box. From Numbers Fledged, we see that the TRES utilize many more nest boxes than the WEBL, and thus produce many more fledges overall. Note: generally, when different species compete for a resource (e.g., a nesting site), the larger (heavier) species prevails; so, it is interesting to note that while the TRES are smaller than the WEBL; they are seemingly more aggressive and often act in groups (four to six TRES divebombing a pair of WEBL). However, there are exceptions, where the WEBL do eject the TRES.

If our results from LLC are indicative of the larger whole, combining the TRES's propensity to seasonally change mates (versus the WEBL's tendency toward monogamy) with the TRES often having two nesting cycles per season and the WEBL tending to have only one, would likely result in more genetic diversity in the TRES than with the WEBL; and therefore, perhaps a better chance for the TRES to adapt to changing environmental conditions.

When one factors in the range and migratory behavior of the birds while also looking at the more urban environmental conditions (traffic, brush clearing, tree trimming, etc.), as we do in a very basic manner in Appendices 5 & 6, a more comprehensive environmental picture begins to emerge. It could be instructive to duplicate the methodology (natural v urban and cavity dweller v a more urban adapted species like the Black Phoebe), employed in Appendix 6, to other areas along the TRES's migration route, for comparison.

Additionally, recognizing what an intensive effort is required to band birds and track them in this manner, to explore other technologies (ever better and less expensive) such as GPS tracking or the use of RFD tags on the birds and reading devices at the holes of the individual boxes, to expand this effort while reducing the amount of time and human energy required.

As DNA analysis becomes ever less expensive, it promises to provide a very cost effective and accurate way of tracking the birds through fecal samples (of course, having a nest box makes this all much simpler).

Finally, to point out that the intensive monitoring carried out in this project was only really feasible because of the use of nest boxes and volunteer labor. Nest boxes provide a very high-quality habitat while being easily accessible for monitoring; while also making it easier to capture specific birds in a relatively safe, for the bird, manner. Also nest boxes afford a situation where nest predation is relatively low when compared to non-cavity nesters.

An overall observation in all of this is that there is a lot more complexity in a bird's life than one might imagine from looking up the bird in a bird-identification app. This is especially true when one considers that this report is just touching on some of the basics and that, if one takes the trouble to look, there is much more to see. For example, how the fact that one TRES pair might only use a few feathers in their nest, while another pair nearly fills the box with feathers and how that may affect the viability of their nest and whether these propensities follow them as they mate with others. And if we are also tracking their DNA, if we can locate the genes affecting this behavior.

APPENDIX 1

Mating Diversity in TRES v WEBL

When we first began banding, we were surprised at the apparent frequency with which the TRES apparently changed mates; particularly with respect to the WEBL. Now, with data from six years, we will attempt to quantify this; given that there can be other factors confusing the issue; namely the death of one mate or the capture of a ‘floater’ at the time of banding. (Floaters are interlopers, who have either not found a mate or a nest box; or potentially, may be a ‘helper’ with a nesting attempt, and opportunistically co-inhabit an established pair’s nest box. See Appendix 2).

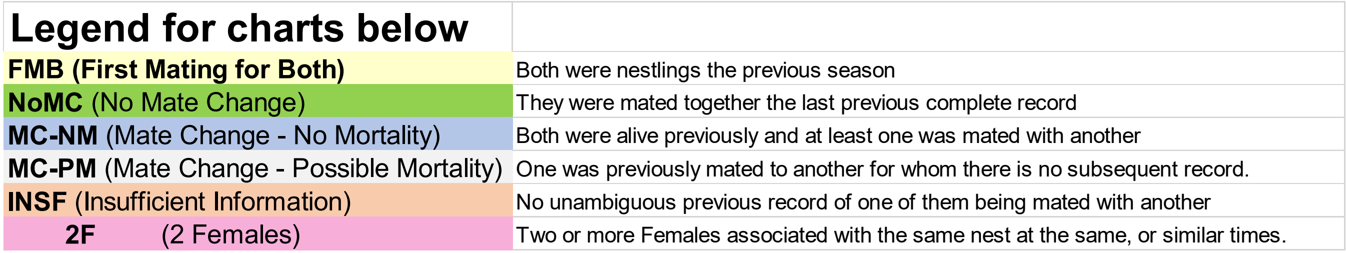
Our observations were hampered by the amount of time and energy required to do the banding; consequently, we were only able to inspect and/or band the birds at best, once or twice per nesting cycle; except in 2020, when due to the COVID pandemic, we could not manage even this.

In future research, it would be very useful to have some sort of automated system to identify the birds entering the nest box; such as RFID tags on the birds and a reader at the entrance hole. This would help enormously in sorting out the issues around “floaters” and help figure out what is going on with other issues such as multiple females in one nest and the difficulty to always capture both of the parents at one time.

In order to investigate mating diversity, we first reorganized the data for each year and nesting cycle so that the relevant data for that year and nesting cycle are close together and organized by box number. This greatly facilitates keeping the relationships straight.

Then using the methodology below, we classified each nesting occurrence as to which category the mating pair likely fits.

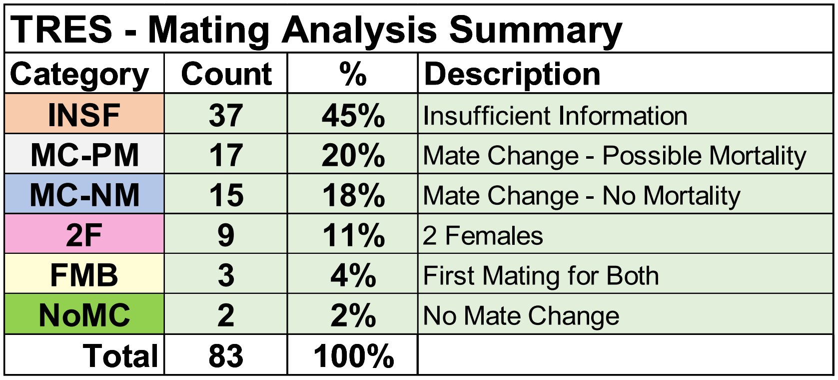
SUMMARY OF RESULTS



Legend for charts below	
FMB (First Mating for Both)	Both were nestlings the previous season
NoMC (No Mate Change)	They were mated together the last previous complete record
MC-NM (Mate Change - No Mortality)	Both were alive previously and at least one was mated with another
MC-PM (Mate Change - Possible Mortality)	One was previously mated to another for whom there is no subsequent record.
INSF (Insufficient Information)	No unambiguous previous record of one of them being mated with another
2F (2 Females)	Two or more Females associated with the same nest at the same, or similar times.

Fig. AP1a Legend of Possible Mating Categories

TRES

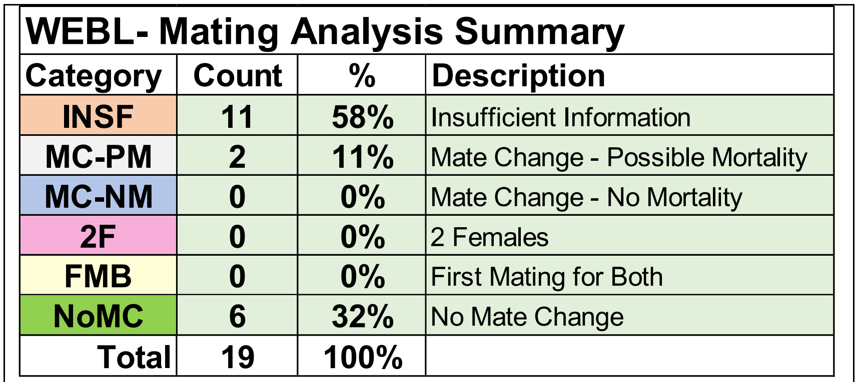


TRES - Mating Analysis Summary

Category	Count	%	Description
INSF	37	45%	Insufficient Information
MC-PM	17	20%	Mate Change - Possible Mortality
MC-NM	15	18%	Mate Change - No Mortality
2F	9	11%	2 Females
FMB	3	4%	First Mating for Both
NoMC	2	2%	No Mate Change
Total	83	100%	

Fig. AP1b TRES Mating Summary

WEBL



WEBL- Mating Analysis Summary

Category	Count	%	Description
INSF	11	58%	Insufficient Information
MC-PM	2	11%	Mate Change - Possible Mortality
MC-NM	0	0%	Mate Change - No Mortality
2F	0	0%	2 Females
FMB	0	0%	First Mating for Both
NoMC	6	32%	No Mate Change
Total	19	100%	

Fig. AP1c WEBL Mating Summary

For the six years of the banding study, **TRES** exhibited a **Mate Change (MC-xx) 38%** of the time and **No Mate Change 2%** of the time.

Whereas **WEBL** essentially showed the reverse – **Mate Change (MC-xx) 11%** and **No Mate Change 32%** of the time.

So, the WEBL seem to have a much greater predilection to stay with the same mate from season to season than do the TRES.

From the results tabulated in Fig. AP1b and AP1c, we see that the category **INSF** (Insufficient Information) has **45%** and **58%** of the entries. This is largely due to the short time in which this study has been going; but also, because so many of the birds are being seen for the first time (AHY); therefore, there is little history with which to provide an evaluation.

Surprisingly, for TRES, the fourth highest classification, at **11%**, is **2F** (**Two Females**). This could indicate a high percentage of female 'floaters' eager to take advantage of the presiding female's absence from the nest. However, that Female 1881-49124, box L21 has four entries, two with the same other female which poses some questions to that hypothesis and also to the hypothesis that the second female is often a younger ‘helper’. We cannot really say; but this category might be worth exploring further.

However, there is a small amount of data on TRES mating pairs from the 1st and 2nd nest cycle of the same year. In 2019, two different pairs kept the same partner for both the 1st and 2nd nest cycle; while one other pair changed partners (see Fig. AP1## 2019-2nd Cycle Mating Pair Analysis). It is interesting to note that these two pairs were the only **NoMC** incidences observed so far in this study for TRES.

It would seem, that for TRES, continuing on with the same mate is the exception rather than the rule.

Methodology for Evaluating Status of Mated Pairs

Looking at Mating Data for each year and nesting cycle:

First: Start with the highlighted (Bold) Year and Nest-Cycle.

Second: For each mated pair, look to the LEFT, in the chart, and determine if either one was part of a previous mated pair.

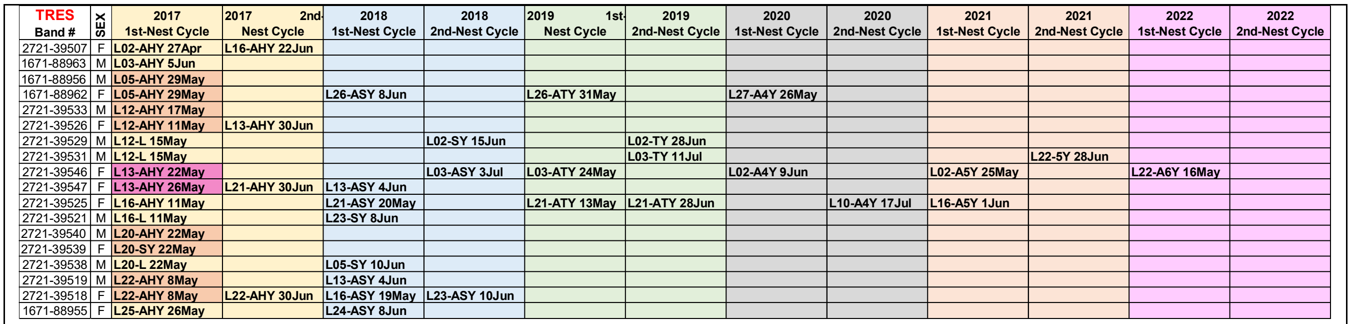
> If **NOT**, then there is insufficient information for evaluation and the category for this entry is **INSF**.
>
> If **SO**, and it is the same mated pair, then their category for this entry is **NoMC** (No Mate-Change)
>
> If **SO**, AND **BOTH** of the previous pair have the designation, 'L' (Nestling), then this mated pair is **FMB** (First Mating for Both)
>
> If **SO**, AND **ONLY ONE** of the previous pair has the designation, '**L**", then this mated pair is either **MC-PM** (Mate Change Possible Mortality) or **MC-NM** (Mate Change No Mortality). This assumes that an adult will mate each year with someone.
>
> To decide:
>
> **first** see if there is a record for any previous year for the one who was an adult.
>
> > If there is, is there a record for who their mate(s) was (were)?
> >
> > > If so, is there a record for any of them in the present, or future years?
> > >
> > > > If **SO**, then it is **MC-NM** (Mate Change-No Mortality) (for that previous mate was available for mating in the present year and at least one chose another.

If **NOT**, then it is **MC-PM** (Mate Change-Possible Mortality) as it may be that the previous mate has died; however, it also may not have been captured; so, this designation may change in a future if that previous mate reappears.

The following charts first give the organized raw data and then specific analysis of each mating pair:

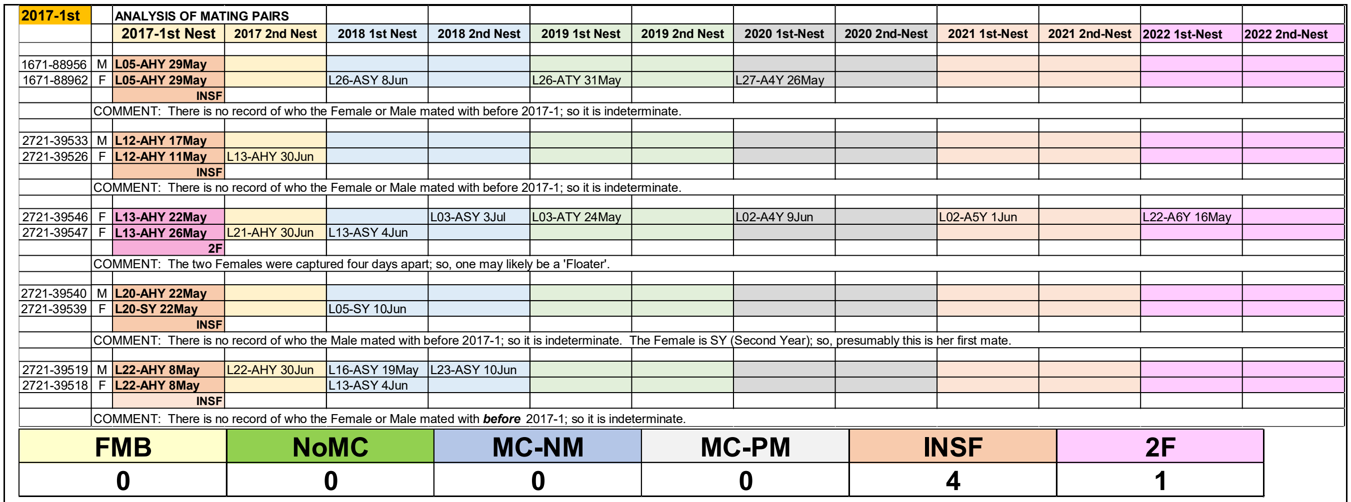
Figures of Mating DATA and ANALYSIS

TRES



TRES Band #	SEX	2017 1st-Nest Cycle	2017 2nd-Nest Cycle	2018 1st-Nest Cycle	2018 2nd-Nest Cycle	2019 1st-Nest Cycle	2019 2nd-Nest Cycle	2020 1st-Nest Cycle	2020 2nd-Nest Cycle	2021 1st-Nest Cycle	2021 2nd-Nest Cycle	2022 1st-Nest Cycle	2022 2nd-Nest Cycle
2721-39507	F	L02-AHY 27Apr	L16-AHY 22Jun										
1671-88963	M	L03-AHY 5Jun											
1671-88956	M	L05-AHY 29May											
1671-88962	F	L05-AHY 29May		L26-ASY 8Jun		L26-ATY 31May		L27-A4Y 26May					
2721-39533	M	L12-AHY 17May											
2721-39526	F	L12-AHY 11May	L13-AHY 30Jun										
2721-39529	M	L12-L 15May			L02-SY 15Jun		L02-TY 28Jun						
2721-39531	M	L12-L 15May					L03-TY 11Jul				L22-5Y 28Jun		
2721-39546	F	L13-AHY 22May			L03-ASY 3Jul	L03-ATY 24May		L02-A4Y 9Jun		L02-A5Y 25May		L22-A6Y 16May	
2721-39547	F	L13-AHY 26May	L21-AHY 30Jun	L13-ASY 4Jun									
2721-39525	F	L16-AHY 11May		L21-ASY 20May		L21-ATY 13May	L21-ATY 28Jun		L10-A4Y 17Jul	L16-A5Y 1Jun			
2721-39521	M	L16-L 11May		L23-SY 8Jun									
2721-39540	M	L20-AHY 22May											
2721-39539	F	L20-SY 22May											
2721-39538	M	L20-L 22May		L05-SY 10Jun									
2721-39519	M	L22-AHY 8May		L13-ASY 4Jun									
2721-39518	F	L22-AHY 8May	L22-AHY 30Jun	L16-ASY 19May	L23-ASY 10Jun								
1671-88955	F	L25-AHY 26May		L24-ASY 8Jun									

Fig. AP1d TRES 2017-1st Cycle TRES Mating Data



2017-1st		ANALYSIS OF MATING PAIRS											
		2017-1st Nest	2017 2nd Nest	2018 1st Nest	2018 2nd Nest	2019 1st Nest	2019 2nd Nest	2020 1st-Nest	2020 2nd-Nest	2021 1st-Nest	2021 2nd-Nest	2022 1st-Nest	2022 2nd-Nest
1671-88956	M	L05-AHY 29May											
1671-88962	F	L05-AHY 29May		L26-ASY 8Jun		L26-ATY 31May		L27-A4Y 26May					
		INSF											
	COMMENT: There is no record of who the Female or Male mated with before 2017-1; so it is indeterminate.												
2721-39533	M	L12-AHY 17May											
2721-39526	F	L12-AHY 11May	L13-AHY 30Jun										
		INSF											
	COMMENT: There is no record of who the Female or Male mated with before 2017-1; so it is indeterminate.												
2721-39546	F	L13-AHY 22May			L03-ASY 3Jul	L03-ATY 24May		L02-A4Y 9Jun		L02-A5Y 1Jun		L22-A6Y 16May	
2721-39547	F	L13-AHY 26May	L21-AHY 30Jun	L13-ASY 4Jun									
		2F											
	COMMENT: The two Females were captured four days apart; so, one may likely be a 'Floater'.												
2721-39540	M	L20-AHY 22May											
2721-39539	F	L20-SY 22May		L05-SY 10Jun									
		INSF											
	COMMENT: There is no record of who the Male mated with before 2017-1; so it is indeterminate. The Female is SY (Second Year); so, presumably this is her first mate.												
2721-39519	M	L22-AHY 8May	L22-AHY 30Jun	L16-ASY 19May	L23-ASY 10Jun								
2721-39518	F	L22-AHY 8May		L13-ASY 4Jun									
		INSF											
	COMMENT: There is no record of who the Female or Male mated with ***before*** 2017-1; so it is indeterminate.												

FMB	NoMC	MC-NM	MC-PM	INSF	2F
0	0	0	0	4	1

Fig. AP1e TRES 2017-1st Cycle TRES Mating Pair Analysis

TRES Band #	SEX	2017 1st-Nest Cycle	2017 2nd-Nest Cycle	2018 1st-Nest Cycle	2018 2nd-Nest Cycle	2019 1st-Nest Cycle	2019 2nd-Nest Cycle	2020 1st-Nest Cycle	2020 2nd-Nest Cycle	2021 1st-Nest Cycle	2021 2nd-Nest Cycle	2022 1st-Nest Cycle	2022 2nd-Nest Cycle
1671-88972	M		L02-AHY 16Jun			L03-ATY 24May							
1671-88973	F		L02-SY 16Jun	L19-TY 28May		L19-4Y 17May	L15-4Y 28Jun						
1671-88970	M		L02-L 16Jun	L24-SY 8Jun									
1881-49112	F		L05-AHY 7Jul	L28-ASY 30May	L13-ASY 21Jul		L11-ATY 28Jun						
1671-88974	M		L10-AHY 18Jun										
1671-88984	F		L10-SY 22Jun	L10-TY 19May									
1881-49109	F		L13-AHY 7Jul	L12-ASY 24May	L20-ASY 21Jul	L20-ATY 17May							
2721-39526	F	L12-AHY 11May	L13-AHY 30Jun										
1671-88985	M		L16-AHY 22Jun	L16-ASY 19May									
2721-39507	F	L02-AHY 27Apr	L16-AHY 22Jun										
1881-49113	F		L20-SY 7Jul	L20-TY 28May		L22-4Y 31May							
1671-88995	M		L21-AHY 30Jun										
2721-39547	F	L13-AHY 26May	L21-AHY 30Jun	L13-ASY 4Jun									
2721-39518	F	L22-AHY 8May	L22-AHY 30Jun	L16-ASY 19May	L23-ASY 10Jun								

Fig. AP1f TRES 2017-2nd Cycle TRES Mating Data

2017-2nd		ANALYSIS OF MATING PAIRS											
		2017-1st Nest	2017 2nd Nest	2018 1st Nest	2018 2nd Nest	2019 1st Nest	2019 2nd Nest	2020 1st-Nest	2020 2nd-Nest	2021 1st-Nest	2021 2nd-Nest	2021 1st-Nest	2021 2nd-Nest
1671-88972	M		L02-AHY 16Jun			L03-ATY 24May							
1671-88973	F		L02-SY 16Jun	L19-TY 28May		L19-4Y 17May	L15-4Y 28Jun						
			INSF										
	COMMENT: The Female and Male have no previous mates recorded. INSF												
1671-88974	M		L10-AHY 18Jun										
1671-88984	F		L10-SY 22Jun	L10-TY 19May									
			INSF										
	COMMENT: The Female and Male have no previous mates recorded. INSF												
2721-39526	F	L12-AHY 11May	L13-AHY 30Jun										
1881-49109	F		L13-AHY 7Jul	L12-ASY 24May	L20-ASY 21Jul	L20-ATY 17May							
			2F										
	COMMENT: The two Females were captured 1 week apart; so one was likely a 'Floater'. Eggs were laid in this 2nd-Nest near 8 June and the nestlings fledged near 13 July.												
1671-88985	M		L16-AHY 22Jun	L16-ASY 19May									
2721-39507	F	L02-AHY 27Apr	L16-AHY 22Jun										
			INSF										
	COMMENT: There is no record of who the Male mated with in 2017-1, or before; so it is indeterminate.												
1671-88995	M		L21-AHY 30Jun										
2721-39547	F	L13-AHY 26May	L21-AHY 30Jun	L13-ASY 4Jun									
			INSF										
	COMMENT: There is no record of who the Male mated with in 2017-1, or before; so it is indeterminate.												

FMB	NoMC	MC-NM	MC-PM	INSF	2F
0	0	0	0	4	1

Fig. AP1g TRES 2017-2nd Cycle TRES Mating Pair Analysis

TRES Band #	SEX	2017 1st-Nest Cycle	2017 2nd-Nest Cycle	2018 1st-Nest Cycle	2018 2nd-Nest Cycle	2019 1st-Nest Cycle	2019 2nd-Nest Cycle	2020 1st-Nest Cycle	2020 2nd-Nest Cycle	2021 1st-Nest Cycle	2021 2nd-Nest Cycle	2022 1st-Nest Cycle	2022 2nd-Nest Cycle
1881-49183	F			L05-AHY 10Jun									
2721-39538	M	L20-L 22May		L05-SY 10Jun									
1671-88984	F		L10-SY 22Jun	L10-TY 19May									
1881-49148	F			L11-AHY 30May									
1881-49109	F		L13-AHY 7Jul	L12-ASY 24May	L20-ASY 21Jul	L20-ATY 17May							
1881-49130	M			L12-AHY 24May									
2721-39519	M	L22-AHY 8May		L13-ASY 4Jun									
2721-39547	F	L13-AHY 26May	L21-AHY 30Jun	L13-ASY 4Jun									
2721-39518	F	L22-AHY 8May	L22-AHY 30Jun	L16-ASY 19May	L23-ASY 10Jun								
1671-88985	M		L16-AHY 22Jun	L16-ASY 19May									
1671-88973	F		L02-SY 16Jun	L19-TY 28May		L19-4Y 17May	L15-4Y 28Jun						
1881-49138	M			L19-AHY 28May									
1881-49139	M			L20-AHY 28May									
1881-49113	F		L20-SY 7Jul	L20-TY 28May		L22-4Y 31May							
1881-49124	F			L21-AHY 20May		L21-ASY 13May				L21-A4Y 21May	L21-A4Y 23Jun		
2721-39525	F	L16-AHY 11May		L21-ASY 20May		L21-ATY 13May	L21-ATY 28Jun		L10-A4Y 17Jul	L16-A5Y 1Jun			
1881-49131	M			L21-L 28May						L27-4Y 25May		L27-5Y 18May	
1881-49127	F			L22-AHY 24May		L28-ASY 24May							
1881-49128	M			L22-AHY 24May									
1881-49136	M			L22-L 28May		L12-SY 17May	L19-SY 5Jul						
1881-49173	F			L23-SY 8Jun									
2721-39521	M	L16-L 11May		L23-SY 8Jun									
1671-88955	F	L25-AHY 26May		L24-ASY 8Jun									
1671-88970	M		L02-L 16Jun	L24-SY 8Jun									
1671-88962	F	L05-AHY 29May		L26-ASY 8Jun		L26-ATY 31May		L27-A4Y 26May					
1881-49172	M			L26-AHY 8Jun									
1881-49163	U			L27-L 6Jun		L24-SY 31May							
1881-49112	F		L05-AHY 7Jul	L28-ASY 30May	L13-ASY 21Jul		L11-ATY 28Jun						
1881-49146	F			L29-SY 30May									
1881-49147	M			L29-AHY 30May									

Fig. AP1h TRES 2018-1st Cycle TRES Mating Data

2018-1st		ANALYSIS OF MATING PAIRS											
		2017-1st Nest	2017 2nd Nest	2018 1st Nest	2018 2nd Nest	2019 1st Nest	2019 2nd Nest	2020 1st-Nest	2020 2nd-Nest	2021 1st-Nest	2021 2nd-Nest	2022 1st-Nest	2022 2nd-Nest
1881-49183	F			L05-AHY 10Jun									
2721-39538	M	L20-L 22May		L05-SY 10Jun									
				INSF									
	COMMENT: The male was a nestling the previous season, so it had no previous mate. The Female is AHY, so it is not sure she had a previous mate - so it is indeterminate.												
1881-49130	M			L12-AHY 24May									
1881-49109	F		L13-AHY 7Jul	L12-ASY 24May	L20-ASY 21Jul	L20-ATY 17May							
				INSF									
	COMMENT: As there is no previous information regarding the Male and we do not know who the Female mated with in 2017-2, the status of this couple is indeterminate.												
2721-39518	F	L22-AHY 8May	L22-AHY 30Jun	L16-ASY 19May									
2721-39519	M	L22-AHY 8May		L13-ASY 4Jun									
2721-39547	F	L13-AHY 26May	L21-AHY 30Jun	L13-ASY 4Jun									
				MC-NM									
	COMMENT: The Male was previously mated with Female(2721-39518) who is still alive in 2018-1; so Female(2721-39518) was a possible mate for the Male at this time.												
2721-39519	M	L22-AHY 8May		L13-ASY 4Jun									
2721-39518	F	L22-AHY 8May	L22-AHY 30Jun	L16-ASY 19May									
1671-88985	M		L16-AHY 22Jun	L16-ASY 19May									
2721-39507	F	L02-AHY 27Apr	L16-AHY 22Jun										
				MC-NM									
	COMMENT: The Female(2721-39518) was previously mated with Male(2721-39519) in 2017-1 and he is still alive in 2018-1.												
1671-88972	M		L02-AHY 16Jun			L03-ATY 24May							
1671-88973	F		L02-SY 16Jun	L19-TY 28May		L19-4Y 17May	L15-4Y 28Jun						
1881-49138	M			L19-AHY 28May									
				MC-NM									
	COMMENT: The Female(1671-88973) was previously mated with Male(1671-88972) in 2017-2 and he is still alive in 2019-1.												
1881-49139	M			L20-AHY 28May									
1881-49113	F		L20-SY 7Jul	L20-TY 28May		L22-4Y 31May							
				INSF									
	COMMENT: As there is no previous information regarding the Male and we do not know who the Female mated with in 2017-2, the status of this couple is indeterminate.												
2721-39525	F	L16-AHY 11May		L21-ASY 28May		L21-ASY 13May				L21-A4Y 21May	L21-A4Y 23Jun		
1881-49124	F			L21-AHY 28May		L21-ATY 13May	L21-ATY 5Jul		L10-A4Y 17Jul	L16-A5Y 1Jun			
				2F									
	COMMENT: It is interesting to note that these same two Females were captured together in box L21 the next year and that Female(1881-49124) stayed with box 21 four nesting cycles.												
1881-49128	M			L22-AHY 24May									
1881-49127	F			L22-AHY 24May		L28-ASY 24May							
				INSF									
	COMMENT: As there is no previous information regarding the Female or the Male, the status of this couple is indeterminate.												
2721-39521	M	L16-L 11May		L23-SY 10Jun									
1881-49173	F			L23-SY 8Jun									
				FMB									
	COMMENT: As both are SY (Second Year), neither has had a previous mate; therefore they must be FMB (First Mating for Both).												
1671-88955	F	L25-AHY 26May		L24-ASY 8Jun									
1671-88970	M		L02-L 16Jun	L24-SY 8Jun									
				MC-PM									
	COMMENT: The Male was previously a nestling; but the Female was previously mated to someone else; however there is no record of who that was and could now be dead.												
1671-88956	M	L05-AHY 29May											
1671-88962	F	L05-AHY 29May		L26-ASY 8Jun		L26-ATY 31May		L27-A4Y 26May					
1881-49172	M			L26-AHY 8Jun									
				MC-PM									
	COMMENT: There is no previous record of the Male and while the Female was previously mated with Male(1671-88956), there is no subsequent record of him.												
1881-49146	F			L29-SY 30May									
1881-49147	M			L29-AHY 30May									
				INSF									
	COMMENT: As there is no previous information regarding the Female or the Male, the status of this couple is indeterminate.												

FMB	NoMC	MC-NM	MC-PM	INSF	2F
1	0	3	2	5	1

Fig. AP1i TRES 2018-1st Cycle TRES Mating Pair Analysis

TRES Band #	SEX	2017 1st-Nest Cycle	2017 2nd-Nest Cycle	2018 1st-Nest Cycle	2018 2nd-Nest Cycle	2019 1st-Nest Cycle	2019 2nd-Nest Cycle	2020 1st-Nest Cycle	2020 2nd-Nest Cycle	2021 1st-Nest Cycle	2021 2nd-Nest Cycle	2022 1st-Nest Cycle	2022 2nd-Nest Cycle
2721-39529	M	L12-L 15May			L02-SY 15Jun		L02-TY 28Jun						
1881-49184	F				L02-AHY 15Jun								
2721-39546	F	L13-AHY 22May			L03-ASY 3Jul	L03-ATY 24May		L02-A4Y 9Jun		L02-A5Y 25May		L22-A6Y 16May	
1881-49003	M				L12-AHY 3Jul	L19-ASY 17May	L15-ASY 28Jun					L19-A5Y 3Jun	
1881-49199	F				L12-AHY 26Jun								
1881-49112	F		L05-AHY 7Jul	L28-ASY 30May	L13-ASY 21Jul		L11-ATY 28Jun						
1881-49004	F				L15-SY 3Jul	L12-TY 17May	L19-TY 5Jul						
1881-49005	M				L15-AHY 3Jul	L20-ASY 17May	L20-ASY 5Jul			L20-A4Y 30May			
1881-49109	F		L13-AHY 7Jul	L12-ASY 24May	L20-ASY 21Jul	L20-ATY 17May							
2721-39518	F	L22-AHY 8May	L22-AHY 30Jun	L16-ASY 19May	L23-ASY 10Jun								
1881-49006	M				L25-AHY 3Jul			L27-ATY 26May					
1881-49011	F				L25-AHY 10Jul								
1881-49010	F				L27-AHY 10Jul								

Fig. AP1j TRES 2018-2nd Cycle TRES Mating Data

2018-2nd		ANALYSIS OF MATING PAIRS											
		2017-1st Nest	2017 2nd Nest	2018 1st Nest	2018 2nd Nest	2019 1st Nest	2019 2nd Nest	2020 1st-Nest	2020 2nd-Nest	2021 1st-Nest	2021 2nd-Nest	2022 1st-Nest	2022 2nd-Nest
2721-39529	M	L12-L 15May			L02-SY 15Jun		L02-TY 28Jun						
1881-49184	F				L02-AHY 15Jun								
					INSF								
	COMMENT: As there is no other information regarding the Female and it is the first mention of the Male since it was a nestling, the status of this couple is indeterminate.												
1881-49199	F				L12-AHY 26Jun								
1881-49003	M				L12-AHY 3Jul	L19-ASY 17May	L15-ASY 28Jun					L19-A5Y 3Jun	
					INSF								
	COMMENT: As there is no previous information regarding either of the pair, as well, they were not captured on the same day, the status of this couple is indeterminate.												
1881-49004	F				L15-SY 3Jul	L12-TY 17May	L19-TY 5Jul						
1881-49005	M				L15-AHY 3Jul	L20-ASY 17May	L20-ASY 5Jul			L20-A4Y 30May	L20-A4Y 4Jun		
					INSF								
	COMMENT: As there is no previous information regarding either of the pair, the status of this couple is indeterminate.												
1881-49006	M				L25-AHY 3Jul			L27-ATY 26May					
1881-49011	F				L25-AHY 10Jul								
					INSF								
	COMMENT: As there is no previous information regarding either of the pair, the status of this couple is indeterminate.												

FMB	NoMC	MC-NM	MC-PM	INSF	2F
0	0	0	0	4	0

Fig. AP1k TRES 2018-2nd Cycle TRES Mating Pair Analysis

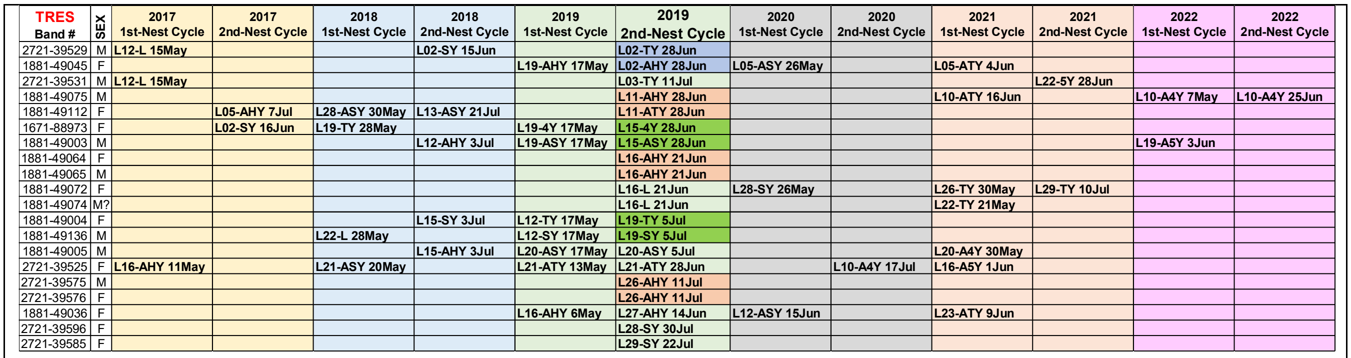
TRES Band #	SEX	2017 1st-Nest Cycle	2017 2nd-Nest Cycle	2018 1st-Nest Cycle	2018 2nd-Nest Cycle	2019 1st-Nest Cycle	2019 2nd-Nest Cycle	2020 1st-Nest Cycle	2020 2nd-Nest Cycle	2021 1st-Nest Cycle	2021 2nd-Nest Cycle	2022 1st-Nest Cycle	2022 2nd-Nest Cycle
2721-39546	F	L13-AHY 22May			L03-ASY 3Jul	L03-ATY 24May		L02-A4Y 9Jun		L02-A5Y 25May		L22-A6Y 16May	
1671-88972	M		L02-AHY 16Jun			L03-ATY 24May							
1671-89074	F					L05-AHY 24May							
1671-89075	M					L05-AHY 24May							
1671-89067	M					L05-L 24May			L03-SY 6Jul	L23-TY 16Jun		L03-4Y 9Jun	
1671-89053	F					L10-AHY 17May							
1881-49136	M			L22-L 28May		L12-SY 17May	L19-SY 5Jul						
1881-49004	F				L15-SY 3Jul	L12-TY 17May	L19-TY 5Jul						
1671-89063	F					L12-L 17May				L11-TY 25May			
1671-89064	F					L12-L 17May						L20-4Y 16May	
1671-89098	M?					L13-AHY 7Jun							
1881-49036	F					L16-AHY 6May	L27-AHY 14Jun	L12-ASY 15Jun		L23-ATY 9Jun			
1881-49052	F					L18-L 7Jun				L13-TY 4Jun			
1881-49003	M				L12-AHY 3Jul	L19-ASY 17May	L15-ASY 28Jun					L19-A5Y 3Jun	
1671-88973	F		L02-SY 16Jun	L19-TY 28May		L19-4Y 17May	L15-4Y 28Jun						
1881-49045	F					L19-AHY 17May	L02-AHY 28Jun	L05-ASY 26May		L05-ATY 4Jun			
1881-49005	M				L15-AHY 3Jul	L20-ASY 17May	L20-ASY 5Jul			L20-A4Y 30May			
1881-49109	F		L13-AHY 7Jul	L12-ASY 24May	L20-ASY 21Jul	L20-ATY 17May							
1881-49124	F			L21-AHY 20May		L21-ASY 13May				L21-A4Y 21May	L21-A4Y 23Jun		
2721-39525	F	L16-AHY 11May		L21-ASY 20May		L21-ATY 13May	L21-ATY 28Jun		L10-A4Y 17Jul	L16-A5Y 1Jun			
1881-49113	F		L20-SY 7Jul	L20-TY 28May		L22-4Y 31May							
1881-49058	M					L23-AHY 14Jun							
1881-49062	F					L23-AHY 14Jun		L01-ASY 22Jun					
1881-49163	U			L27-L 6Jun		L24-SY 31May							
1671-89094	F					L24-AHY 31May							
1671-89087	M					L26-L 31May						L20-4Y 26Jun	
1671-88962	F	L05-AHY 29May		L26-ASY 8Jun		L26-ATY 31May		L27-A4Y 26May					
1881-49127	F			L22-AHY 24May		L28-ASY 24May							
1671-89076	M					L28-AHY 24May		L28-ASY 26May		L13-ATY 9Jun			
1671-89082	U					L29-AHY 31May							

Fig. AP1l TRES 2019-1st Cycle TRES Mating Data

2019-1st		**ANALYSIS OF MATING PAIRS**											
		2017 1st-Nest	**2017 2nd-Nest**	**2018 1st-Nest**	**2018 2nd-Nest**	**2019 1st-Nest**	**2019 2nd-Nest**	**2020 1st-Nest**	**2020 2nd-Nest**	**2021 1st-Nest**	**2021 2nd-Nest**	**2022 1st-Nest**	**2022 2nd-Nest**
1671-88973	F		L02-SY 16Jun	L19-TY 28May		**L19-4Y 17May**	L02-AHY 28Jun	L05-ASY 26May		L05-ATY 4Jun			
2721-39546	F	L13-AHY 22May			L03-ASY 3Jul	**L03-ATY 24May**		L02-A4Y 9Jun		L02-A5Y 1Jun		**L22-A6Y 16May**	
1671-88972	M		L02-AHY 16Jun			**L03-ATY 24May**							
						MC-NM							
	COMMENT: As Male (1671-88972) was mated with Female (1671-88973) in 2017, and she is mated with another in 2019, then the pair M(1671-88972)-F(271-39546) is (Mate Change No Mortality) **MC-NM**.												
1671-89074	F					**L05-AHY 24May**							
1671-89075	M					**L05-AHY 24May**							
						INSF							
	COMMENT: As there is no previous information regarding either of the pair, the status of this couple is indeterminate.												
1881-49005	M				L15-AHY 3Jul	**L20-ASY 17May**	L20-ASY 5Jul			L20-A4Y 30May	L20-A4Y 4Jun		
1881-49004	F				L15-SY 3Jul	**L12-TY 17May**	L19-TY 5Jul						
1881-49136	M			L22-L 28May		**L12-SY 17May**	L19-SY 5Jul						
						MC-NM							
	COMMENT: Mate Change - No Mortality; as in the previous year, F(1881-49004) was mated to a different Male, who lived on and was present as a mating choice.												
1671-88972	M		L02-AHY 16Jun			**L03-ATY 24May**							
1881-49199	F				L12-AHY 26Jun								
1881-49003	M				L12-AHY 3Jul	**L19-ASY 17May**	L15-ASY 28Jun					**L19-A5Y 3Jun**	
1671-88973	F		L02-SY 16Jun	L19-TY 28May		**L19-4Y 17May**	L15-4Y 28Jun						
1881-49045	F					**L19-AHY 17May**	L02-AHY 28Jun	L05-ASY 26May		L05-ATY 4Jun			
1881-49138	M			L19-AHY 28May									
						MC-NM							
	COMMENT: This one Is a bit complicated as it is interconnected with the 2F category (next, below). Choosing Male(1881-49003) and Female(1671-88973) as the primary pair (as they continue together in the 2nd nest cycle, while F(1881-49045) goes off with a different mate in the 2nd nest cycle), we see that in 2017-2, F(1671-88973) mated with a different M(1671-88972) and he was still alive in 2019 and with someone else. Hence we can classify this as (Mate Change - No Mortality) **MC-NM**.												
1881-49003	M				L12-AHY 3Jul	**L19-ASY 17May**	L15-ASY 28Jun						
1671-88973	F		L02-SY 16Jun	L19-TY 28May		**L19-4Y 17May**	L15-4Y 28Jun						
1881-49045	F					**L19-AHY 17May**	L02-AHY 28Jun	L05-ASY 26May		L05-ATY 4Jun			
						2F							
	COMMENT: At the same time (relatively) that the presumed mating pair, M(1881-49003) and F(1671-88973), were caught, so was F(1881-49045). The unresolved questions are whether she is a floater of the moment or the 'true' mate, or whether she is a longer-term 'helper' with the presumed mating pair (see previous entry for that discussion).												
1881-49004	F				L15-SY 3Jul	**L12-TY 17May**	L19-TY 5Jul						
1881-49005	M				L15-AHY 3Jul	**L20-ASY 17May**	L20-ASY 5Jul			L20-A4Y 30May	L20-A4Y 4Jun		
1881-49109	F		L13-AHY 7Jul	L12-ASY 24May	L20-ASY 21Jul	**L20-ATY 17May**							
						MC-NM							
	COMMENT: Both Male and Female were mated with others in 2018-2												
1881-49124	F			L21-AHY 28May		**L21-ASY 13May**				L21-A4Y 21May	L21-A4Y 23Jun		
2721-39525	F	L16-AHY 11May		L21-ASY 28May		**L21-ATY 13May**	L21-ATY 5Jul		L10-A4Y 17Jul	L16-A5Y 1Jun			
						2F							
	COMMENT: Two Females at same box at same time. ***Also at same box at same time the previous year.***												
1881-49062	F					**L23-AHY 14Jun**		L01-ASY 22Jun					
1881-49058	M					**L23-AHY 21Jun**							
						INSF							
	COMMENT: As they are both AHY (After Hatch Year), each could be 2nd, 3rd, 4th, … year, and there is no previous sign of them, there is insufficient information to classify them.												
1881-49163	U			L27-L 6Jun		**L24-SY 31May**							
1671-89094	F					**L24-AHY 31May**							
						INSF							
	COMMENT: As the sex of one is indeterminate, and there is no previous history for the other; then there is Insufficient information to categorize them.												
1671-89076	M					**L28-AHY 24May**			L28-ASY 26May	L13-ATY 9Jun			
1881-49127	F			L22-AHY 24May		**L28-ASY 24May**							
1881-49128	M			L22-AHY 24May									
						MC-PM							
	COMMENT: There was a mate change as Female(1881-49127) had a different mate in 2018-1; however there is no record of this male since; so, he may have died. **MC-PM**.												

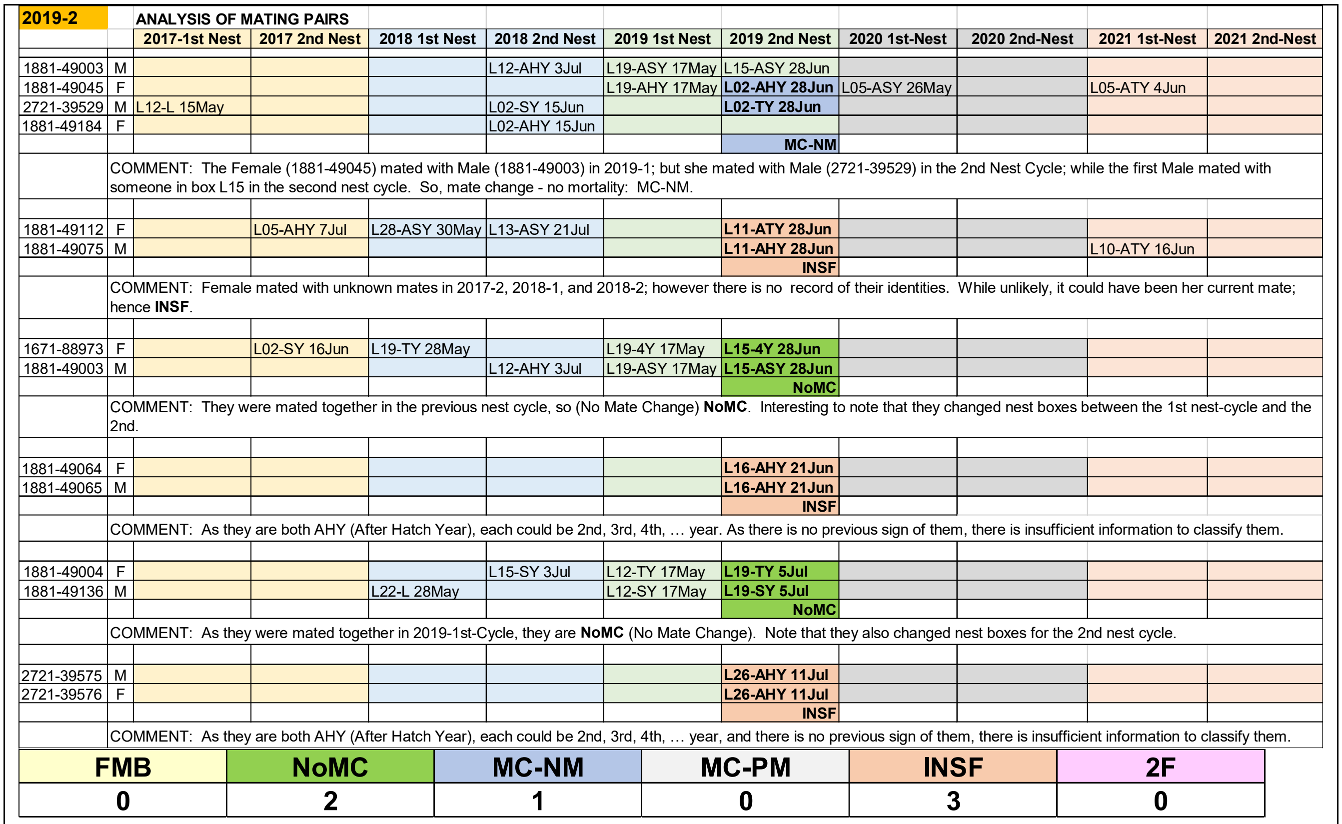
FMB	**NoMC**	**MC-NM**	**MC-PM**	**INSF**	**2F**
0	**0**	**4**	**1**	**3**	**2**

Fig. AP1m TRES 2019-1st Cycle TRES Mating Pair Analysis



TRES Band #	SEX	2017 1st-Nest Cycle	2017 2nd-Nest Cycle	2018 1st-Nest Cycle	2018 2nd-Nest Cycle	2019 1st-Nest Cycle	2019 2nd-Nest Cycle	2020 1st-Nest Cycle	2020 2nd-Nest Cycle	2021 1st-Nest Cycle	2021 2nd-Nest Cycle	2022 1st-Nest Cycle	2022 2nd-Nest Cycle
2721-39529	M	L12-L 15May			L02-SY 15Jun		L02-TY 28Jun						
1881-49045	F					L19-AHY 17May	L02-AHY 28Jun	L05-ASY 26May		L05-ATY 4Jun			
2721-39531	M	L12-L 15May					L03-TY 11Jul				L22-5Y 28Jun		
1881-49075	M						L11-AHY 28Jun			L10-ATY 16Jun		L10-A4Y 7May	L10-A4Y 25Jun
1881-49112	F		L05-AHY 7Jul	L28-ASY 30May	L13-ASY 21Jul		L11-ATY 28Jun						
1671-88973	F		L02-SY 16Jun	L19-TY 28May		L19-4Y 17May	L15-4Y 28Jun						
1881-49003	M				L12-AHY 3Jul	L19-ASY 17May	L15-ASY 28Jun					L19-A5Y 3Jun	
1881-49064	F						L16-AHY 21Jun						
1881-49065	M						L16-AHY 21Jun						
1881-49072	F						L16-L 21Jun	L28-SY 26May		L26-TY 30May	L29-TY 10Jul		
1881-49074	M?						L16-L 21Jun			L22-TY 21May			
1881-49004	F				L15-SY 3Jul	L12-TY 17May	L19-TY 5Jul						
1881-49136	M			L22-L 28May		L12-SY 17May	L19-SY 5Jul						
1881-49005	M				L15-AHY 3Jul	L20-ASY 17May	L20-ASY 5Jul			L20-A4Y 30May			
2721-39525	F	L16-AHY 11May		L21-ASY 20May		L21-ATY 13May	L21-ATY 28Jun		L10-A4Y 17Jul	L16-A5Y 1Jun			
2721-39575	M						L26-AHY 11Jul						
2721-39576	F						L26-AHY 11Jul						
1881-49036	F					L16-AHY 6May	L27-AHY 14Jun	L12-ASY 15Jun		L23-ATY 9Jun			
2721-39596	F						L28-SY 30Jul						
2721-39585	F						L29-SY 22Jul						

Fig. AP1n TRES 2019-2nd Cycle TRES Mating Data



2019-2		ANALYSIS OF MATING PAIRS									
		2017-1st Nest	2017 2nd Nest	2018 1st Nest	2018 2nd Nest	2019 1st Nest	2019 2nd Nest	2020 1st-Nest	2020 2nd-Nest	2021 1st-Nest	2021 2nd-Nest
1881-49003	M				L12-AHY 3Jul	L19-ASY 17May	L15-ASY 28Jun				
1881-49045	F					L19-AHY 17May	**L02-AHY 28Jun**	L05-ASY 26May		L05-ATY 4Jun	
2721-39529	M	L12-L 15May			L02-SY 15Jun		**L02-TY 28Jun**				
1881-49184	F				L02-AHY 15Jun						
							MC-NM				
	COMMENT: The Female (1881-49045) mated with Male (1881-49003) in 2019-1; but she mated with Male (2721-39529) in the 2nd Nest Cycle; while the first Male mated with someone in box L15 in the second nest cycle. So, mate change - no mortality: MC-NM.										
1881-49112	F		L05-AHY 7Jul	L28-ASY 30May	L13-ASY 21Jul		**L11-ATY 28Jun**				
1881-49075	M						**L11-AHY 28Jun**			L10-ATY 16Jun	
							INSF				
	COMMENT: Female mated with unknown mates in 2017-2, 2018-1, and 2018-2; however there is no record of their identities. While unlikely, it could have been her current mate; hence **INSF**.										
1671-88973	F		L02-SY 16Jun	L19-TY 28May		L19-4Y 17May	**L15-4Y 28Jun**				
1881-49003	M				L12-AHY 3Jul	L19-ASY 17May	**L15-ASY 28Jun**				
							NoMC				
	COMMENT: They were mated together in the previous nest cycle, so (No Mate Change) **NoMC**. Interesting to note that they changed nest boxes between the 1st nest-cycle and the 2nd.										
1881-49064	F						**L16-AHY 21Jun**				
1881-49065	M						**L16-AHY 21Jun**				
							INSF				
	COMMENT: As they are both AHY (After Hatch Year), each could be 2nd, 3rd, 4th, … year. As there is no previous sign of them, there is insufficient information to classify them.										
1881-49004	F				L15-SY 3Jul	L12-TY 17May	**L19-TY 5Jul**				
1881-49136	M			L22-L 28May		L12-SY 17May	**L19-SY 5Jul**				
							NoMC				
	COMMENT: As they were mated together in 2019-1st-Cycle, they are **NoMC** (No Mate Change). Note that they also changed nest boxes for the 2nd nest cycle.										
2721-39575	M						**L26-AHY 11Jul**				
2721-39576	F						**L26-AHY 11Jul**				
							INSF				
	COMMENT: As they are both AHY (After Hatch Year), each could be 2nd, 3rd, 4th, … year, and there is no previous sign of them, there is insufficient information to classify them.										

FMB	NoMC	MC-NM	MC-PM	INSF	2F
0	2	1	0	3	0

Fig. AP1o TRES 2019-2nd Cycle Mating Pair Analysis

TRES Band #	SEX	2017 1st-Nest Cycle	2017 2nd-Nest Cycle	2018 1st-Nest Cycle	2018 2nd-Nest Cycle	2019 1st-Nest Cycle	2019 2nd-Nest Cycle	2020 1st-Nest Cycle	2020 2nd-Nest Cycle	2021 1st-Nest Cycle	2021 2nd-Nest Cycle	2022 1st-Nest Cycle	2022 2nd-Nest Cycle
1881-49249	M							L01-AHY 22Jun		L29-ASY 25May			
1881-49062	F					L23-AHY 14Jun		L01-ASY 22Jun					
2721-39561	M							L02-AHY 9Jun					
2721-39546	F	L13-AHY 22May			L03-ASY 3Jul	L03-ATY 24May		L02-A4Y 9Jun		L02-A5Y 25May		L22-A6Y 16May	
1881-49239	F							L02-L 9Jun		L15-SY 30May		L15-TY 11May	
1881-49045	F					L19-AHY 17May	L02-AHY 28Jun	L05-ASY 26May		L05-ATY 4Jun			
1881-49201	M							L05-L 26May		L28-SY 23May		L28-TY 26May	
1881-49202	M							L05-L 26May		L12-SY 23May			
1881-49210	M							L10-AHY 26May		L05-ASY 4Jun			
1881-49209	F							L10-SY 26May		L19-TY 21May			
1881-49036	F					L16-AHY 6May	L27-AHY 14Jun	L12-ASY 15Jun		L23-ATY 9Jun			
1881-49247	F							L12-L 15Jun			L22-SY 28Jun		
1881-49248	F							L15-AHY 15Jun		L10-ASY 16Jun			
1881-49223	M							L16-L 29May		L15-SY 30May		L18-TY 16May	
1881-49228	F							L24-AHY 29May					
1881-49234	F							L25-AHY 29May					
1881-49006	M				L25-AHY 3Jul			L27-ATY 26May					
1671-88962	F	L05-AHY 29May		L26-ASY 8Jun		L26-ATY 31May		L27-A4Y 26May					
1671-89076	M					L28-AHY 24May		L28-ASY 26May		L13-ATY 9Jun			
1881-49072	F						L16-L 21Jun	L28-SY 26May		L26-TY 30May	L29-TY 10Jul		

Fig. AP1p TRES 2020-1st Cycle Mating Data

2020-1st		ANALYSIS OF MATING PAIRS											
		2017 1st-Nest	2017 2nd-Nest	2018 1st-Nest	2018 2nd-Nest	2019 1st-Nest	2019 2nd-Nest	2020 1st-Nest	2020 2nd-Nest	2021 1st-Nest	2021 2nd-Nest	2022 1st-Nest	2022 2nd-Nest
1881-49249	M							L01-AHY 22Jun		L29-ASY 25May			
1881-49062	F					L23-AHY 14Jun		L01-ASY 22Jun					
1881-49058	M					L23-AHY 21Jun							
								MC-PM					
	COMMENT: The Female was mated with a different Male in 2019 and he was not seen in 2020 or 2021; so may have died.												
1671-88972	M		L02-AHY 16Jun			L03-ATY 24May							
2721-39561	M							L02-AHY 9Jun					
2721-39546	F	L13-AHY 22May			L03-ASY 3Jul	L03-ATY 24May		L02-A4Y 9Jun		L02-A5Y 1Jun		L22-A6Y 16May	
								MC-PM					
	COMMENT: The Female was mated with a different Male in 2019 and he was not seen in 2020 or 2021; so may have died.												
1881-49210	M							L10-AHY 26May		L05-ASY 4Jun			
1881-49209	F							L10-SY 26May		L19-TY 21May			
								INSF					
	COMMENT: While this is the Female's first breeding season; there is Insufficient Information to determine if the Male mated the previous year.												
1671-88956	M	L05-AHY 29May											
1881-49172	M			L26-AHY 8Jun									
1881-49006	M				L25-AHY 3Jul			L27-ATY 26May					
1671-88962	F	L05-AHY 29May		L26-ASY 8Jun		L26-ATY 31May		L27-A4Y 26May					
1881-49011	F				L25-AHY 10Jul								
								MC-PM					
	COMMENT: Both the Male (1881-49006) and the Female (1671-88962) had previously mated with others; however none of the others were seen again, and may have died.												
1881-49127	F			L22-AHY 24May		L28-ASY 24May							
1671-89076	M					L28-AHY 24May		L28-ASY 26May		L13-ATY 9Jun			
1881-49072	F						L16-L 21Jun	L28-SY 26May		L26-TY 30May	L29-TY 10Jul		
								MC-PM					
	COMMENT: This is the Female's first breeding season; and there is no further Information about the Male's previous mate, who may have died..												

FMB	NoMC	MC-NM	MC-PM	INSF	2F
0	0	0	4	1	0

Fig. AP1q TRES 2020-1st Cycle Mating Pair Analysis

TRES Band #	SEX	2017 1st-Nest Cycle	2017 2nd-Nest Cycle	2018 1st-Nest Cycle	2018 2nd-Nest Cycle	2019 1st-Nest Cycle	2019 2nd-Nest Cycle	2020 1st-Nest Cycle	2020 2nd-Nest Cycle	2021 1st-Nest Cycle	2021 2nd-Nest Cycle	2022 1st-Nest Cycle	2022 2nd-Nest Cycle
1671-89067	M					L05-L 24May			L03-SY 6Jul	L23-TY 16Jun		L03-4Y 9Jun	
1881-49251	F								L03-SY 6Jul				
1881-49259	F								L03-SY 13Jul	L20-TY 30May		L10-4Y 7May	
2721-39525	F	L16-AHY 11May		L21-ASY 20May		L21-ATY 13May	L21-ATY 28Jun		L10-A4Y 17Jul	L16-A5Y 1Jun			
1881-49252	F								L29-AHY 6Jul				

Fig. AP1r TRES 2020-2nd Cycle Mating Data

2020-2nd		ANALYSIS OF MATING PAIRS											
		2017 1st Nest	2017 2nd Nest	2018 1st Nest	2018 2nd Nest	2019 1st Nest	2019 2nd Nest	2020 1st-Nest	2020 2nd Nest	2021 1st Nest	2021 2nd Nest	2022 1st Nest	2022 2nd Nest
1671-89067	M					L05-L 24May			L03-SY 6Jul	L23-TY 16Jun			
1881-49251	F								L03-SY 6Jul				
1881-49259	F								L03-SY 13Jul				
									FMB				
	COMMENT: We have somewhat arbitrarily taken Male (1671-89067) and Female (1881-49251) as the mating pair as they were both captured at the same time; while Female (1881-49259) was captured by herself one week later. The classification would be FMB regardless, as they are all SY (Second Year); so this would be their first mating season.												
1881-49251	F								L03-SY 6Jul				
1881-49259	F								L03-SY 13Jul	L20-TY 4Jun			
									2F				
	COMMENT: Female(1881-49259) appears to be an opportunistic 'Floater', as she was captured one week later.												

FMB	NoMC	MC-NM	MC-PM	INSF	2F
1	0	0	0	0	1

Fig. AP1s TRES 2020-2nd Cycle Mating Pair Analysis

TRES Band #	SEX	2017 1st-Nest Cycle	2017 2nd-Nest Cycle	2018 1st-Nest Cycle	2018 2nd-Nest Cycle	2019 1st-Nest Cycle	2019 2nd-Nest Cycle	2020 1st-Nest Cycle	2020 2nd-Nest Cycle	2021 1st-Nest Cycle	2021 2nd-Nest Cycle	2022 1st-Nest Cycle	2022 2nd-Nest Cycle
1881-49286	M									L02-AHY 25May		L05-ASY 18May	L05-ASY 9Jul
2721-39546	F	L13-AHY 22May			L03-ASY 3Jul	L03-ATY 24May		L02-A4Y 9Jun		L02-A5Y 25May		L22-A6Y 16May	
1881-49210	M							L10-AHY 26May		L05-ASY 4Jun			
1881-49045	F					L19-AHY 17May	L02-AHY 28Jun	L05-ASY 26May		L05-ATY 4Jun			
1881-49075	M						L11-AHY 28Jun			L10-ATY 16Jun		L10-A4Y 7May	L10-A4Y 25Jun
1881-49248	F							L15-AHY 15Jun		L10-ASY 16Jun			
2811-64828	F									L10-L 16Jun			L28-SY 9Jul
1881-49285	M									L11-AHY 25May		L11-ASY 11May	L11-ASY 26Jun
1671-89063	F					L12-L 17May				L11-TY 25May			
1881-49202	M							L05-L 26May		L12-SY 23May			
1881-49270	F									L12-AHY 23May		L12-ASY 16May	
1671-89076	M					L28-AHY 24May		L28-ASY 26May		L13-ATY 9Jun			
1881-49052	F					L18-L 7Jun				L13-TY 4Jun			
2811-64816	F									L13-L 9Jun			L15-SY 25Jun
1881-49223	M							L16-L 29May		L15-SY 30May		L18-TY 16May	
1881-49239	F							L02-L 9Jun		L15-SY 30May		L15-TY 11May	
2811-64805	F									L15-L 4Jun			L11-SY 25Jun
2721-39525	F	L16-AHY 11May		L21-ASY 20May		L21-ATY 13May	L21-ATY 28Jun		L10-A4Y 17Jul	L16-A5Y 1Jun			
1881-49298	M									L16-L 1Jun			L22-SY 9Jul
2811-64824	M									L18-AHY 16Jun			
2811-64821	F									L18-AHY 16Jun			
2811-64835	M									L18-L 19Jun		L21-SY 16May	
1881-49209	F							L10-SY 26May		L19-TY 21May			
1881-49005	M				L15-AHY 3Jul	L20-ASY 17May	L20-ASY 5Jul			L20-A4Y 30May			
1881-49259	F								L03-SY 13Jul	L20-TY 30May		L10-4Y 7May	
2811-64810	F									L20-L 4Jun		L19-SY 3Jun	
1881-49265	F									L21-AHY 21May		L11-ASY 11May	
1881-49124	F			L21-AHY 20May		L21-ASY 13May				L21-A4Y 21May	L21-A4Y 23Jun		
1881-49074	M?						L16-L 21Jun			L22-TY 21May			
2721-39597	F									L22-AHY 21May		L05-ASY 18May	
1671-89067	M					L05-L 24May			L03-SY 6Jul	L23-TY 16Jun		L03-4Y 9Jun	
1881-49036	F					L16-AHY 6May	L27-AHY 14Jun	L12-ASY 15Jun		L23-ATY 9Jun			
1881-49072	F						L16-L 21Jun	L28-SY 26May		L26-TY 30May	L29-TY 10Jul		
1881-49131	M			L21-L 28May						L27-4Y 25May		L27-5YR 18May	
1881-49283	F									L27-AHY 25May			L27-ASY 1Jul
1881-49201	M							L05-L 26May		L28-SY 23May		L28-TY 26May	
1881-49271	F									L28-AHY 23May		L21-ASY 16May	
1881-49249	M							L01-AHY 22Jun		L29-ASY 25May			
1881-49284	F									L29-AHY 25May		L13-ASY 11May	
1881-49276	F									L29-L 25May		L18-SY 16May	

Fig. AP1t TRES 2021-1st Cycle Mating Data

2021-1st		ANALYSIS OF MATING PAIRS											
		2017 1st Nest	2017 2nd Nest	2018 1st Nest	2018 2nd Nest	2019 1st Nest	2019 2nd Nest	2020 1st-Nest	2020 2nd Nest	2021 1st Nest	2021 2nd Nest	2022 1st-Nest	2022 2nd Nest
1881-49286	M									**L02-AHY 1Jun**		**L05-ASY 18May**	**L05-ASY 9Jul**
2721-39546	F	L13-AHY 22May			L03-ASY 3Jul	L03-ATY 24May		L02-A4Y 9Jun		**L02-A5Y 1Jun**		**L22-A6Y 16May**	
2721-39561	M							L02-AHY 9Jun					
1671-88972	M		L02-AHY 16Jun			L03-ATY 24May							
								previous mate		**MC-PM**			
	COMMENT: The Female mated in 2020-1 with a different Male(2721-39561 and in 2019-1 with M(1671-88972); but there is no subsequent record for either; so they may have died.												
1881-49045	F					L19-AHY 17May	L02-AHY 28Jun	L05-ASY 26May		**L05-ATY 4Jun**			
1881-49210	M							L10-AHY 26May		**L05-ASY 4Jun**			
1881-49209	F							L10-SY 26May		**L19-TY 21May**			
										MC-NM			
	COMMENT: The Male mated with a different Female in 2020-1 (1881-49209); and she is alive in 2021, mated with someone else in box L19.												
1881-49112	F		L05-AHY 7Jul	L28-ASY 30May	L13-ASY 21Jul		L11-ATY 28Jun						
1881-49075	M						L11-AHY 28Jun			**L10-ATY 16Jun**		**L10-A4Y 7May**	**L10-A4Y 25Jun**
1881-49248	F							L15-AHY 15Jun		**L10-ASY 16Jun**			
										MC-PM			
	COMMENT: Male mated with Female(1881-49112) in 2019-2; however there is no further record of her - possibly dead; so **MC-PM.**												
1881-49285	M									**L11-AHY 25May**		**L11-ASY 11May**	**L11-ASY 26Jun**
1671-89063	F					L12-L 17May				**L11-TY 25May**			
						nestling		unknown mate		**INSF**			
	COMMENT: Both adults have previously mated; but there is no record; so, **INSF**.												
1881-49270	F									**L12-AHY 23May**		**L12-ASY 16May**	
1881-49202	M							L05-L 26May		**L12-SY 30May**			
								nestling		**INSF**			
	COMMENT: The Male was a nestling the previous year and there is no history for the Female, who is AHY; so, could have had any number of previous mates.												
1881-49127	F			L22-AHY 24May		L28-ASY 24May							
1671-89076	M					L28-AHY 24May			L28-ASY 26May	**L13-ATY 9Jun**			
1881-49052	F					L18-L 7Jun				**L13-TY 9Jun**			
						different Female				**MC-PM**			
	COMMENT: The Male mated with a different Female in 2019-1; but there is no further record of her (she may have died).												
1881-49223	M							L16-L 29May		**L15-SY 4Jun**		**L18-TY 16May**	
1881-49239	F							L02-L 9Jun		**L15-SY 4Jun**		**L15-TY 11May**	
										FMB			
	COMMENT: Both were nestlings in the previous year; so, this was their first mating.												
2811-64821	F									**L18-AHY 16Jun**			
2811-64824	M									**L18-AHY 16Jun**			
										INSF			
	COMMENT: They are both of indeterminate age and we have no previous record of them; so, **INSF**.												
1881-49005	M				L15-AHY 3Jul	L20-ASY 17May	L20-ASY 5Jul			**L20-A4Y 30May**	L20-A4Y 4Jun		
1881-49259	F								L03-SY 13Jul	**L20-TY 4Jun**		**L10-4Y 7May**	
1671-89067	M					L05-AHY 24May			L03-SY 6Jul	**L23-TY 16Jun**			
										MC-NM			
	COMMENT: MC-NM because Female 1881-49005 had mated with Male 1671-89067 in 2020-2 and who is still alive in 2021.												
1881-49124	F			L21-AHY 28May		L21-ASY 13May				**L21-A4Y 21May**	L21-A4Y 23Jun		
1881-49265	F									**L21-AHY 21May**		**L11-ASY 11May**	
										2F			
	COMMENT: Both Females were captured on the same day and Female(1881-49124) has a history of being captured with other females.												
2721-39597	F									**L22-AHY 21May**			
1881-49074	U						L16-L 21Jun			**L22-TY 21May**			
							nestling	unknown mate		**INSF**			
	COMMENT: Both adults have previously mated; but there is no record; so, **INSF**.												
1671-89074	F					L05-AHY 24May		no record	no record	no record			
1671-89067	M					L05-AHY 24May			L03-SY 6Jul	**L23-TY 16Jun**		**L03-4Y 9Jun**	
1881-49036	F					L27-AHY 14Jun		L12-ASY 15Jun		**L23-ATY 9Jun**			
1881-49259	F					no mate record			L03-SY 13Jul	**L20-TY 4Jun**			
1881-49251	F								L03-SY 6Jul				
										MC-PM			
	Female's 2019 mate at all. In 2020, the Male mated with one other female, but we can not tell which one as they were both in Box L03, only one week apart. The Female (1881-49251) that												
1881-49283	F									**L27-AHY 25May**			**L27-ASY 1Jul**
1881-49131	M			L21-L 28May						**L27-4Y 25May**		**L27-5YR 18May**	
				nestling		unknown mate		unknown mate		**INSF**			
	COMMENT: There is no previous record for the Female and none for the Male, except that it was a nestling in 2018-1.												
1881-49271	F									**L28-AHY 23May**		**L21-ASY 16May**	
1881-49201	M							L05-L 26May		**L28-SY 23May**		**L28-TY 26May**	
								nestling		**INSF**			
	COMMENT: The Female has no previous record and the Male was a nestling the previous year; so **INSF**.												
1881-49284	F									**L29-AHY 25May**		**L13-ASY 11May**	
1881-49249	M							L01-AHY 22Jun		**L29-ASY 25May**			
1881-49062	F					L23-AHY 14Jun		L01-ASY 22Jun					
								previous mate		**MC-PM**			
	COMMENT: The Male mated in 2020-1 with a different Female; but there is no subsequent record for her (so she may have died).												

FMB	NoMC	MC-NM	MC-PM	INSF	2F
1	0	2	5	6	1

Fig. AP1u TRES 2021-1st Cycle Mating Pair Analysis

TRES Band #	SEX	2017 1st-Nest Cycle	2017 2nd-Nest Cycle	2018 1st-Nest Cycle	2018 2nd-Nest Cycle	2019 1st-Nest Cycle	2019 2nd-Nest Cycle	2020 1st-Nest Cycle	2020 2nd-Nest Cycle	2021 1st-Nest Cycle	2021 2nd-Nest Cycle	2022 1st-Nest Cycle	2022 2nd-Nest Cycle
2811-64847	F										L19-AHY 17Jul	L02-ASY 23May	
2811-64839	F										L21-AHY 28Jun	L26-ASY 26May	
1881-49124	F			L21-AHY 20May		L21-ASY 13May				L21-A4Y 21May	L21-A4Y 23Jun		
2721-39531	M	L12-L 15May					L03-TY 11Jul				L22-5Y 28Jun		
1881-49247	F							L12-L 15Jun			L22-SY 28Jun		
2811-64830	F										L25-AHY 19Jun	L25-AHY 19Jun	
2811-64846	M										L29-AHY 10Jul		
1881-49072	F						L16-L 21Jun	L28-SY 26May		L26-TY 30May	L29-TY 10Jul		

Fig. AP1v TRES 2021-2nd Cycle Mating Data

2021-2nd		ANALYSIS OF MATING PAIRS											
		2017 1st Nest	2017 2nd Nest	2018 1st Nest	2018 2nd Nest	2019 1st Nest	2019 2nd Nest	2020 1st-Nest	2020 2nd Nest	2021 1st Nest	2021 2nd Nest	2021 1st Nest	2021 2nd Nest
2811-64839	F										L21-AHY 28Jun	**L26-ASY 26May**	
1881-49124	F			L21-AHY 28May		L21-ASY 13May				L21-A4Y 21May	L21-A4Y 23Jun		
1881-49265	F									L21-AHY 21May			
2721-39525	F	L16-AHY 11May		L21-ASY 28May		L21-ATY 13May	L21-ATY 5Jul		L10-A4Y 17Jul	L16-A5Y 1Jun			
		unknown mate					unknown mate		unknown mate		**2F**		
	COMMENT: In 2021-2nd-Nest, box L21, two Female TRES were captured five days apart. We are guessing that Female(2811-64839) was an opportunistic 'floater' because Female(1881-49124) was consistently with box L21 since 2018. It is intersting to note that in 2018-1, 2019-1, and 2021-1 she was also with another female, sampled at the same time, and twice with the same female, one year apart.												
2721-39531	M	L12-L 15May					L03-TY 11Jul				L22-5Y 5Jul		
1881-49247	F							L12-L 15Jun			L22-SY 5Jul		
		nestling					unknown mate	nestling			**MC-PM**		
	COMMENT: Male (2721-39531) was mated to someone else in 2019-2nd-Nest. It wasn't his mate in 2021 because she was only hatched in 2020-1st-Nest. So, classification (Mate Change - Possible Mortality) **MC-PM**.												
1881-49072	F						L16-L 21Jun	L28-SY 26May		L26-TY 30May	L29-TY 10Jul		
2811-64846	M										L29-AHY 10Jul		
							nestling	unknown mate		unknown mate	**INSF**		
	COMMENT: There is no previous record for the Male and there is no identity available for who the Female mated with in 2019-2, 2020-1, or 2021-1; so **INSF**.												

FMB	NoMC	MC-NM	MC-PM	INSF	2F
0	0	0	1	1	1

Fig. AP1w TRES 2021-2nd Cycle Mating Pair Analysis

TRES Band #	SEX	2017 1st-Nest Cycle	2017 2nd-Nest Cycle	2018 1st-Nest Cycle	2018 2nd-Nest Cycle	2019 1st-Nest Cycle	2019 2nd-Nest Cycle	2020 1st-Nest Cycle	2020 2nd-Nest Cycle	2021 1st-Nest Cycle	2021 2nd-Nest Cycle	2022 1st-Nest Cycle	2022 2nd-Nest Cycle
2881-64860	M											L02-AHY 23May	
2811-64847	F										L19-AHY 17Jul	L02-ASY 23May	
1671-89067	M					L05-L 24May			L03-SY 6Jul	L23-TY 16Jun		L03-4Y 9Jun	
1881-49286	M									L02-AHY 25May		L05-ASY 18May	L05-ASY 9Jul
2721-39597	F									L22-AHY 21May		L05-ASY 18May	
1881-49075	M						L11-AHY 28Jun			L10-ATY 16Jun		L10-A4Y 7May	L10-A4Y 25Jun
1881-49259	F								L03-SY 13Jul	L20-TY 30May		L10-4Y 7May	
1881-49285	M									L11-AHY 25May		L11-ASY 11May	L11-ASY 26Jun
1881-49265	F									L21-AHY 21May		L11-ASY 11May	
1881-49270	F									L12-AHY 23May		L12-ASY 16May	
1881-49284	F									L29-AHY 25May		L13-ASY 11May	
1881-89013	M											L15-AHY 11May	
1881-49239	F							L02-L 9Jun		L15-SY 30May		L15-TY 11May	
1881-49223	M							L16-L 29May		L15-SY 30May		L18-TY 16May	
1881-49276	F									L29-L 25May		L18-SY 16May	
1881-49003	M				L12-AHY 3Jul	L19-ASY 17May	L15-ASY 28Jun					L19-A5Y 3Jun	
2811-64810	F									L20-L 4Jun		L19-SY 3Jun	
1671-89087	M					L26-L 31May						L20-4Y 26Jun	
1671-89064	F					L12-L 17May						L20-4Y 16May	
2811-64835	M									L18-L 19Jun		L21-SY 16May	
1881-49271	F									L28-AHY 23May		L21-ASY 16May	
2721-39546	F	L13-AHY 22May			L03-ASY 3Jul	L03-ATY 24May		L02-A4Y 9Jun		L02-A5Y 25May		L22-A6Y 16May	
2811-64856	F											L24-SY 23May	
2811-64859	M											L24-AHY 23May	
2811-64830	F										L25-AHY 19Jun	L25-AHY 19Jun	
2811-64839	F										L21-AHY 28Jun	L26-ASY 26May	
2881-64870	F											L26-AHY 26May	
1881-49131	M			L21-L 28May						L27-4Y 25May		L27-5Y 18May	
1881-49201	M							L05-L 26May		L28-SY 23May		L28-TY 26May	
2881-64861	F											L28-AHY 23May	
2811-64877	F											L29-SY 26May	

Fig. AP1x TRES 2022-1st Cycle Mating Data

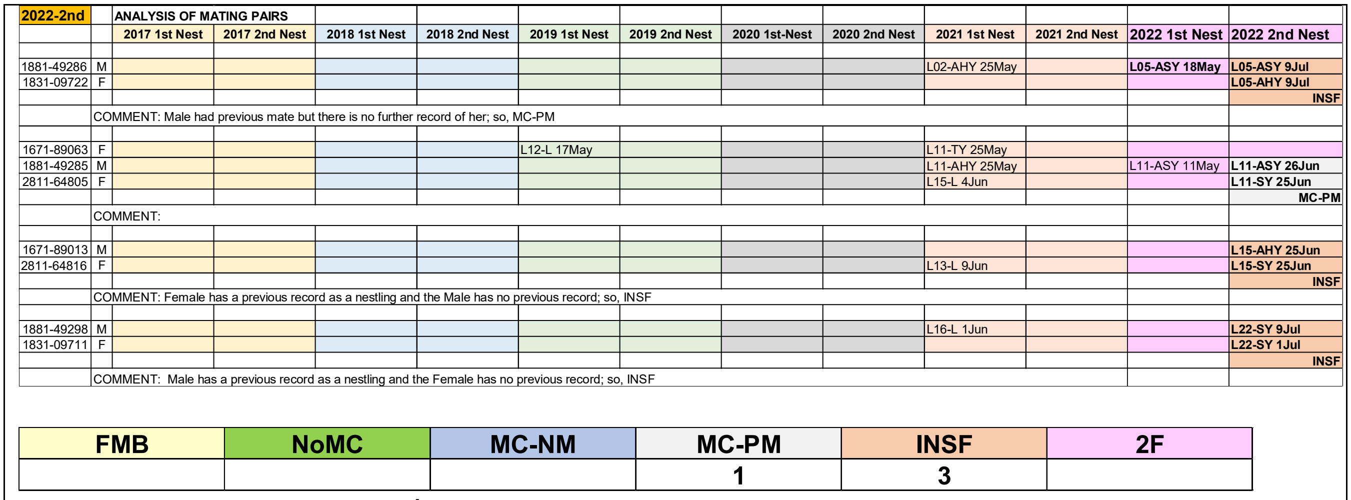
2022-1st		**ANALYSIS OF MATING PAIRS**											
		2017 1st Nest	**2017 2nd Nest**	**2018 1st Nest**	**2018 2nd Nest**	**2019 1st Nest**	**2019 2nd Nest**	**2020 1st-Nest**	**2020 2nd Nest**	**2021 1st Nest**	**2021 2nd Nest**	**2022 1st Nest**	**2022 2nd Nest**
2881-64860	M											**L02-AHY 23May**	
2811-64847	F										L19-AHY 17Jul	**L02-ASY 23May**	
												INSF	
	COMMENT: There is no previous record for the Female or who mated with the Male in 2021-2; so, INSF												
2721-39546	F	L13-AHY 22May			L03-ASY 3Jul	L03-ATY 24May		L02-A4Y 9Jun		L02-A5Y 25May		L22-A6Y 16May	
1881-49286	M									L02-AHY 25May		**L05-ASY 18May**	L05-ASY 9Jul
2721-39597	F									L22-AHY 21May		**L05-ASY 18May**	
1881-49074	M?						L16-L 21Jun			L22-TY 21May			
												MC-NM	
	COMMENT: Male mated previously with F(271-39546) and she was available concurrently - MC-NM												
1881-49248	F							L15-AHY 15Jun		L10-ASY 16Jun			
1881-49075	M						L11-AHY 28Jun			L10-ATY 16Jun		**L10-A4Y 7May**	L10-A4Y 25Jun
1881-49259	F								L03-SY 13Jul	L20-TY 30May		**L10-4Y 7May**	
1881-49005	M				L15-AHY 3Jul	L20-ASY 17May	L20-ASY 5Jul			L20-A4Y 30May			
												MC-PM	
	COMMENT: Both had mated with others previously but there is no further record of those mates: MC-PM												
1671-89063	F					L12-L 17May				L11-TY 25May			
1881-49285	M									L11-AHY 25May		**L11-ASY 11May**	L11-ASY 26Jun
1881-49265	F									L21-AHY 21May		**L11-ASY 11May**	
1881-49124	F			L21-AHY 20May		L21-ASY 13May				L21-A4Y 21May	L21-A4Y 23Jun		
												MC-PM	
	COMMENT: The Male was mated previously with F(1671-89063) but there is no further record of her; and the Female was previously captured with another female but there is no further record of her either, so MC-PM												
1881-89013	M											**L15-AHY 11May**	
1881-49239	F							L02-L 9Jun		L15-SY 30May		**L15-TY 11May**	
1881-49223	M							L16-L 29May		L15-SY 30May		L18-TY 16May	
												MC-NM	
	COMMENT: The Female was previously mated with Male(1881-49223) and he is still available in box L18; so, MC-NM												
1881-49239	F							L02-L 9Jun		L15-SY 30May		**L15-TY 11May**	
1881-49223	M							L16-L 29May		L15-SY 30May		**L18-TY 16May**	
1881-49276	F									L29-L 25May		**L18-SY 16May**	
												MC-NM	
	COMMENT: The Male was previously mated with F(1881-49239) who is still alive and mated elsewhere; so, MC-NM												
1881-49003	M				L12-AHY 3Jul	L19-ASY 17May	L15-ASY 28Jun					**L19-A5Y 3Jun**	
2811-64810	F									L20-L 4Jun		**L19-SY 3Jun**	
												MC-PM	
	COMMENT: The Female was last a nestling and there is no current record of any of the Male's previous mates; so, MC-PM												
1671-89087	M					L26-L 31May						**L20-4Y 26Jun**	
1671-89064	F					L12-L 17May						**L20-4Y 16May**	
												INSF	
	COMMENT: There is no record for either since they were nestlings; so, INSF												
2811-64835	M									L18-L 19Jun		**L21-SY 16May**	
1881-49271	F									L28-AHY 23May		**L21-ASY 16May**	
1881-49201	M							L05-L 26May		L28-SY 23May		L28-TY 26May	
												MC-NM	
	COMMENT: The Female was mated previously to Male(1881-49201) and he presently exists at another box; so, MC-NM												
2811-64856	F											**L24-SY 23May**	
2811-64859	M											**L24-AHY 23May**	
												INSF	
	COMMENT: There is no previous record for either; so, INSF												
2811-64839	F										**L21-AHY 28Jun**	**L26-ASY 26May**	
2881-64870	F											**L26-AHY 26May**	
												2F	
	COMMENT: Both Females were caught at the same time (+/- 20 minutes)												
1881-49271	F									L28-AHY 23May		**L21-ASY 16May**	
1881-49201	M							L05-L 26May		L28-SY 23May		**L28-TY 26May**	
2881-64861	F											**L28-AHY 23May**	
												MC-NM	
	COMMENT: The Male was mated previously with Female(1881-49271) and exist currently at box L21; so, MC-NM												

FMB	**NoMC**	**MC-NM**	**MC-PM**	**INSF**	**2F**
		5	**3**	**3**	**1**

Fig. AP1y TRES 2022-1st Cycle Mating Pair Analysis

TRES Band #	**SEX**	**2017 1st-Nest Cycle**	**2017 2nd-Nest Cycle**	**2018 1st-Nest Cycle**	**2018 2nd-Nest Cycle**	**2019 1st-Nest Cycle**	**2019 2nd-Nest Cycle**	**2020 1st-Nest Cycle**	**2020 2nd-Nest Cycle**	**2021 1st-Nest Cycle**	**2021 2nd-Nest Cycle**	**2022 1st-Nest Cycle**	**2022 2nd-Nest Cycle**
1881-49286	M									L02-AHY 25May		L05-ASY 18May	**L05-ASY 9Jul**
1831-09722	F												**L05-AHY 9Jul**
1881-49075	M						L11-AHY 28Jun			L10-ATY 16Jun		L10-A4Y 7May	**L10-A4Y 25Jun**
1881-49285	M									L11-AHY 25May		L11-ASY 11May	**L11-ASY 26Jun**
2811-64805	F									L15-L 4Jun			**L11-SY 25Jun**
1671-89013	M												**L15-AHY 25Jun**
2811-64816	F									L13-L 9Jun			**L15-SY 25Jun**
1831-09705	F												**L16-SY 26Jun**
1831-09707	F												**L18-SY 26Jun**
1831-09706	F												**L20-AHY 26Jun**
1881-49298	M									L16-L 1Jun			**L22-SY 9Jul**
1831-09711	F												**L22-SY 1Jul**
1881-49283	F									L27-AHY 25May			**L27-ASY 1Jul**
2811-64828	F									L10-L 16Jun			**L28-SY 9Jul**

Fig. AP1z TRES 2022-2nd Cycle Mating Data

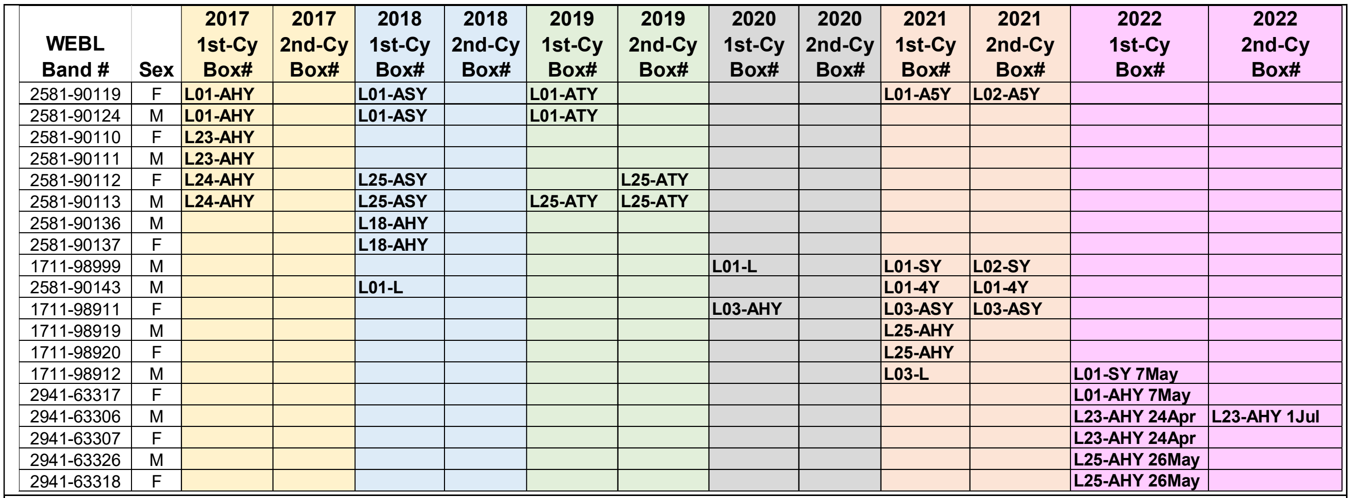


2022-2nd		ANALYSIS OF MATING PAIRS											
		2017 1st Nest	2017 2nd Nest	2018 1st Nest	2018 2nd Nest	2019 1st Nest	2019 2nd Nest	2020 1st-Nest	2020 2nd Nest	2021 1st Nest	2021 2nd Nest	2022 1st Nest	2022 2nd Nest
1881-49286	M									L02-AHY 25May		**L05-ASY 18May**	**L05-ASY 9Jul**
1831-09722	F												**L05-AHY 9Jul**
													INSF
	COMMENT: Male had previous mate but there is no further record of her; so, MC-PM												
1671-89063	F					L12-L 17May				L11-TY 25May			
1881-49285	M									L11-AHY 25May		L11-ASY 11May	**L11-ASY 26Jun**
2811-64805	F									L15-L 4Jun			**L11-SY 25Jun**
													MC-PM
	COMMENT:												
1671-89013	M												**L15-AHY 25Jun**
2811-64816	F									L13-L 9Jun			**L15-SY 25Jun**
													INSF
	COMMENT: Female has a previous record as a nestling and the Male has no previous record; so, INSF												
1881-49298	M									L16-L 1Jun			**L22-SY 9Jul**
1831-09711	F												**L22-SY 1Jul**
													INSF
	COMMENT: Male has a previous record as a nestling and the Female has no previous record; so, INSF												

FMB	NoMC	MC-NM	MC-PM	INSF	2F
			1	3	

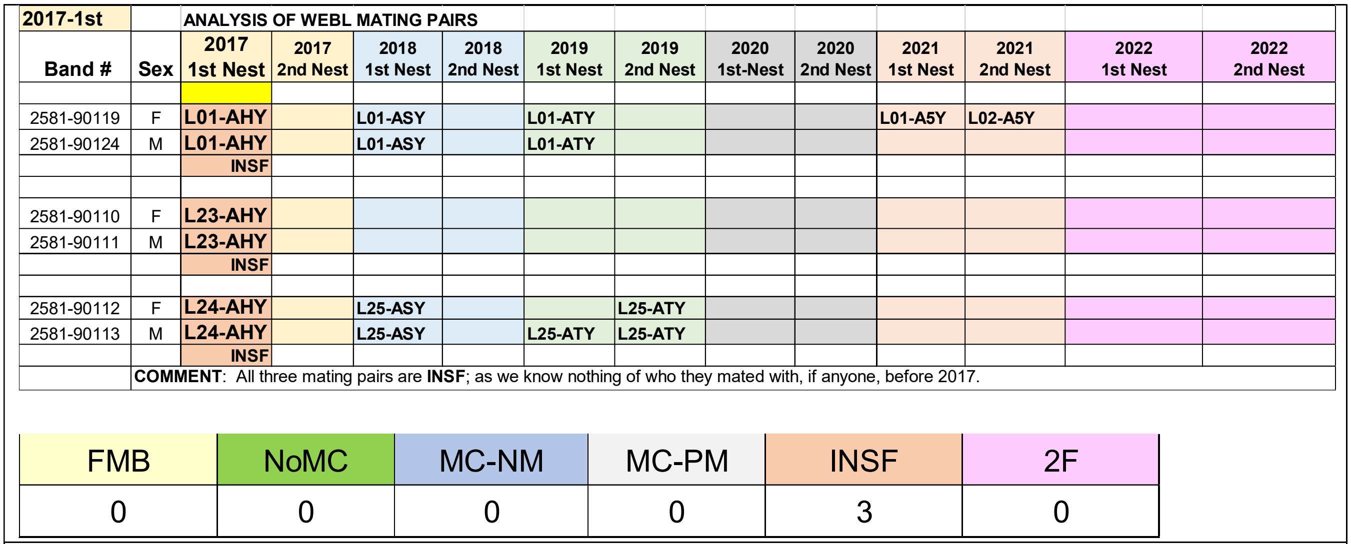
Fig. AP1aa TRES 2022-2nd Cycle Mating Pair Analysis

WEBL Mating Data and Analysis - Details



WEBL Band #	Sex	2017 1st-Cy Box#	2017 2nd-Cy Box#	2018 1st-Cy Box#	2018 2nd-Cy Box#	2019 1st-Cy Box#	2019 2nd-Cy Box#	2020 1st-Cy Box#	2020 2nd-Cy Box#	2021 1st-Cy Box#	2021 2nd-Cy Box#	2022 1st-Cy Box#	2022 2nd-Cy Box#
2581-90119	F	L01-AHY		L01-ASY		L01-ATY				L01-A5Y	L02-A5Y		
2581-90124	M	L01-AHY		L01-ASY		L01-ATY							
2581-90110	F	L23-AHY											
2581-90111	M	L23-AHY											
2581-90112	F	L24-AHY		L25-ASY			L25-ATY						
2581-90113	M	L24-AHY		L25-ASY		L25-ATY	L25-ATY						
2581-90136	M			L18-AHY									
2581-90137	F			L18-AHY									
1711-98999	M							L01-L		L01-SY	L02-SY		
2581-90143	M			L01-L						L01-4Y	L01-4Y		
1711-98911	F							L03-AHY		L03-ASY	L03-ASY		
1711-98919	M									L25-AHY			
1711-98920	F									L25-AHY			
1711-98912	M									L03-L		L01-SY 7May	
2941-63317	F											L01-AHY 7May	
2941-63306	M											L23-AHY 24Apr	L23-AHY 1Jul
2941-63307	F											L23-AHY 24Apr	
2941-63326	M											L25-AHY 26May	
2941-63318	F											L25-AHY 26May	

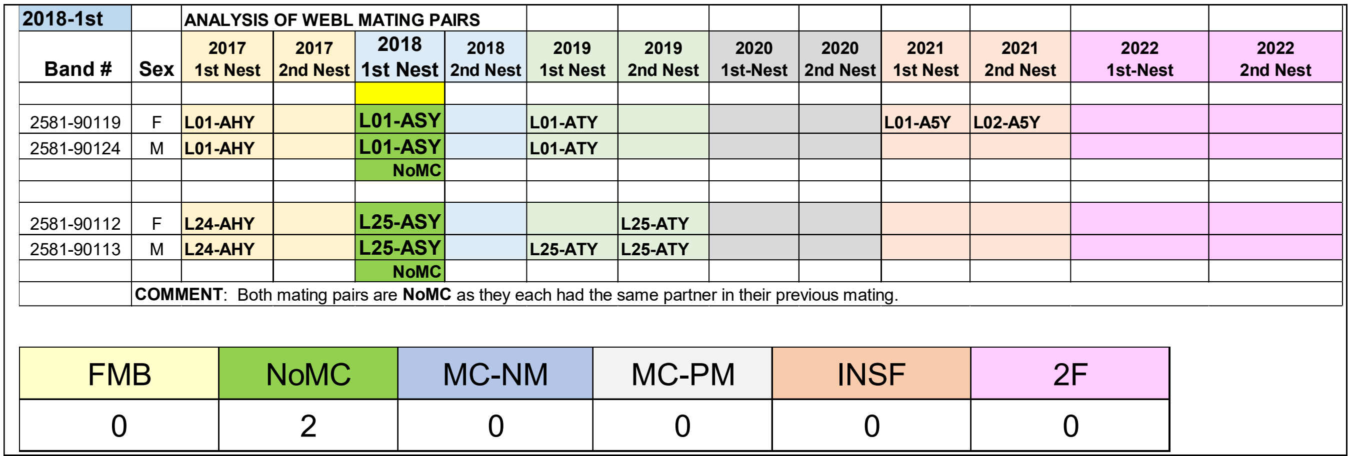
Fig. AP1ab WEBL Banding Record



2017-1st		ANALYSIS OF WEBL MATING PAIRS											
Band #	Sex	2017 1st Nest	2017 2nd Nest	2018 1st Nest	2018 2nd Nest	2019 1st Nest	2019 2nd Nest	2020 1st-Nest	2020 2nd Nest	2021 1st Nest	2021 2nd Nest	2022 1st Nest	2022 2nd Nest
2581-90119	F	L01-AHY		L01-ASY		L01-ATY				L01-A5Y	L02-A5Y		
2581-90124	M	L01-AHY		L01-ASY		L01-ATY							
		INSF											
2581-90110	F	L23-AHY											
2581-90111	M	L23-AHY											
		INSF											
2581-90112	F	L24-AHY		L25-ASY			L25-ATY						
2581-90113	M	L24-AHY		L25-ASY		L25-ATY	L25-ATY						
		INSF											
	COMMENT: All three mating pairs are **INSF**; as we know nothing of who they mated with, if anyone, before 2017.												

FMB	NoMC	MC-NM	MC-PM	INSF	2F
0	0	0	0	3	0

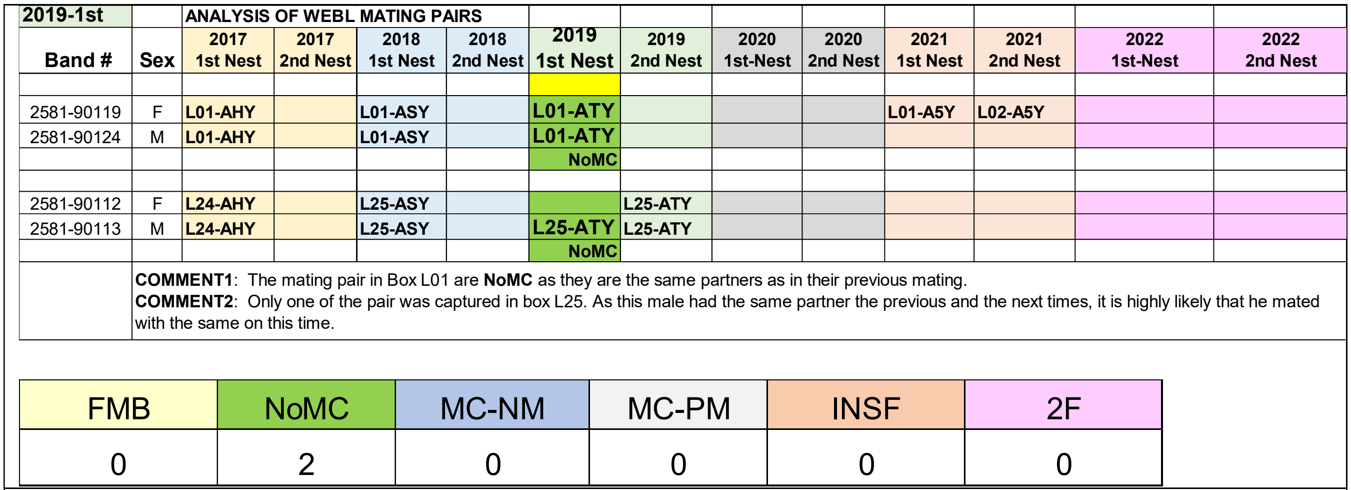
Fig. AP1ac WEBL 2017-1st Cycle Analysis of Mating Pairs



2018-1st		ANALYSIS OF WEBL MATING PAIRS											
Band #	Sex	2017 1st Nest	2017 2nd Nest	2018 1st Nest	2018 2nd Nest	2019 1st Nest	2019 2nd Nest	2020 1st-Nest	2020 2nd Nest	2021 1st Nest	2021 2nd Nest	2022 1st-Nest	2022 2nd Nest
2581-90119	F	L01-AHY		L01-ASY		L01-ATY				L01-A5Y	L02-A5Y		
2581-90124	M	L01-AHY		L01-ASY		L01-ATY							
				NoMC									
2581-90112	F	L24-AHY		L25-ASY			L25-ATY						
2581-90113	M	L24-AHY		L25-ASY		L25-ATY	L25-ATY						
				NoMC									
	COMMENT: Both mating pairs are **NoMC** as they each had the same partner in their previous mating.												

FMB	NoMC	MC-NM	MC-PM	INSF	2F
0	2	0	0	0	0

Fig. AP1ad WEBL 2018-1st Cycle Analysis of Mating Pairs



2019-1st		ANALYSIS OF WEBL MATING PAIRS											
Band #	Sex	2017 1st Nest	2017 2nd Nest	2018 1st Nest	2018 2nd Nest	2019 1st Nest	2019 2nd Nest	2020 1st-Nest	2020 2nd Nest	2021 1st Nest	2021 2nd Nest	2022 1st-Nest	2022 2nd Nest
2581-90119	F	L01-AHY		L01-ASY		L01-ATY				L01-A5Y	L02-A5Y		
2581-90124	M	L01-AHY		L01-ASY		L01-ATY							
						NoMC							
2581-90112	F	L24-AHY		L25-ASY			L25-ATY						
2581-90113	M	L24-AHY		L25-ASY		L25-ATY	L25-ATY						
						NoMC							
	COMMENT1: The mating pair in Box L01 are **NoMC** as they are the same partners as in their previous mating. **COMMENT2**: Only one of the pair was captured in box L25. As this male had the same partner the previous and the next times, it is highly likely that he mated with the same on this time.												

FMB	NoMC	MC-NM	MC-PM	INSF	2F
0	2	0	0	0	0

Fig AP1ae WEBL 2019-1st Cycle Analysis of Mating Pairs

2019-2nd		ANALYSIS OF WEBL MATING PAIRS											
Band #	Sex	2017 1st Nest	2017 2nd Nest	2018 1st Nest	2018 2nd Nest	2019 1st Nest	2019 2nd Nest	2020 1st-Nest	2020 2nd Nest	2021 1st Nest	2021 2nd Nest	2022 1st-Nest	2022 2nd Nest
2581-90112	F	L24-AHY		L25-ASY			L25-ATY						
2581-90113	M	L24-AHY		L25-ASY		L25-ATY	L25-ATY						
							NoMC						

COMMENT: We designate this mating pair as **NoMC** as they were the same partners in the two previous years and there is no evidence that they were not partners in the last nest cycle. This somewhat balances the very conservative designation of INSF for the 2019-1 nest cycle.

FMB	NoMC	MC-NM	MC-PM	INSF	2F
0	1	0	0	0	0

Fig. AP1af WEBL 2019-2nd Cycle Analysis of Mating Pairs

2020-1st		ANALYSIS OF WEBL MATING PAIRS											
Band #	Sex	2017 1st Nest	2017 2nd Nest	2018 1st Nest	2018 2nd Nest	2019 1st Nest	2019 2nd Nest	2020 1st-Nest	2020 2nd Nest	2021 1st Nest	2021 2nd Nest	2022 1st-Nest	2022 2nd Nest
1711-98911	F							L03-AHY		L03-ASY	L03-ASY		
								INSF					

COMMENT: There is no previous information for this 'AHY'; therefore, **INSF**.

FMB	NoMC	MC-NM	MC-PM	INSF	2F
0	0	0	0	1	0

Fig. AP1ag WEBL 2020-1st Cycle Analysis of Mating Pairs

2021-1st		ANALYSIS OF WEBL MATING PAIRS											
Band #	Sex	2017 1st Nest	2017 2nd Nest	2018 1st Nest	2018 2nd Nest	2019 1st Nest	2019 2nd Nest	2020 1st-Nest	2020 2nd Nest	2021 1st Nest	2021 2nd Nest	2022 1st-Nest	2022 2nd Nest
2581-90119	F	L01-AHY		L01-ASY		L01-ATY				L01-A5Y	L02-A5Y		
1711-98999	M							L01-L		L01-SY	L02-SY		
2581-90143	M			L01-L						03May	L01-4Y		
										MC-PM			
1711-98911	F							L03-AHY		L03-ASY	L03-ASY		
										INSF			
1711-98919	M									L25-AHY			
1711-98920	F									L25-AHY			
										INSF			

COMMENT1: In this instance, there are apparently two males associated with this box for the first nest cycle. However, on closer inspection, the second male (2582-90143) was captured by himself on the 3rd of May; while the first male (1711-98999) was captured with the female one month later, on the 4th of June. Also, this same mating pair mated together in the second nest cycle as well. The first nest cycle instance is catagorized as MC-PM because the female had mated in 2019 with a different male (2581-90124) and there is not further record of him - so, **MC-PM**.

COMMENT2: There is no information on the mate for this female (1711-98911), so **INSF**.

COMMENT3: Both mates are 'AHY' so there is no previous information for them; so, **INSF**.

FMB	NoMC	MC-NM	MC-PM	INSF	2F
0	0	0	1	2	0

Fig. AP1ah WEBL 2021-1st Cycle Analysis of Mating Pairs

2021-2nd		ANALYSIS OF WEBL MATING PAIRS											
Band #	Sex	2017 1st Nest	2017 2nd Nest	2018 1st Nest	2018 2nd Nest	2019 1st Nest	2019 2nd Nest	2020 1st-Nest	2020 2nd Nest	2021 1st Nest	2021 2nd Nest	2022 1st-Nest	2022 2nd Nest
2581-90119	F	L01-AHY		L01-ASY		L01-ATY				L01-A5Y	L02-A5Y		
1711-98999	M							L01-L		L01-SY	L02-SY		
											NoMC		
2581-90143	M			L01-L						L01-4Y	L01-4Y		
											INSF		
1711-98911	F							L03-AHY		L03-ASY	L03-ASY		
											INSF		

COMMENT1: The male and female mated together in the previous nest cycle; so, **NoMC**.
COMMENT2: There is no record of this male's mate; so, **INSF**.
COMMENT3: There is no record of this female's mate; so, **INSF**.

FMB	NoMC	MC-NM	MC-PM	INSF	2F
0	1	0	0	2	0

Fig. AP1ai WEBL 2021-2nd Cycle Analysis of Mating Pairs

2022-1st		ANALYSIS OF WEBL MATING PAIRS											
Band #	Sex	2017 1st Nest	2017 2nd Nest	2018 1st Nest	2018 2nd Nest	2019 1st Nest	2019 2nd Nest	2020 1st-Nest	2020 2nd Nest	2021 1st Nest	2021 2nd Nest	2022 1st-Nest	2022 2nd Nest
1711-98912	M									L03-L		L01-SY 7May	
2941-63317	F											L01-AHY 7May	
												MC-PM	
2941-63306	M											L23-AHY 24Apr	L23-AHY 1Jul
2941-63307	F											L23-AHY 24Apr	
												INSF	
2941-63326	M											L25-AHY 26May	
2941-63318	F											L25-AHY 26May	
												INSF	

COMMENT1: Male was previously a nestling; so, Female had a previous mate, for which there is no record; MC-PM
COMMENT2: Both Male and Female are AHY; so, no previous record for either: INSF
COMMENT3: Both Male and Female are AHY: so, no previous record for either: INSF

FMB	NoMC	MC-NM	MC-PM	INSF	2F
0	0	0	1	2	0

Fig. AP1aj WEBL 2022-1st Cycle Analysis of Mating Pairs

2022-2nd		ANALYSIS OF WEBL MATING PAIRS											
Band #	Sex	2017 1st Nest	2017 2nd Nest	2018 1st Nest	2018 2nd Nest	2019 1st Nest	2019 2nd Nest	2020 1st-Nest	2020 2nd Nest	2021 1st Nest	2021 2nd Nest	2022 1st-Nest	2022 2nd Nest
2941-63306	M											L23-AHY 24Apr	L23-AHY 1Jul
													INSF

COMMENT1: No record of any previous mate. INSF

FMB	NoMC	MC-NM	MC-PM	INSF	2F
0	0	0	0	1	0

Fig. AP1ak WEBL 2022-2nd Cycle Analysis of Mating Pairs

APPENDIX 2

Floaters - Consideration of a Significant TRES Floater Population

Floaters, adult individuals physiologically capable of breeding but unable to find a nest site and/or a mate, likely exist within the Lake Los Carneros (LLC) population. Many academic studies have found that floaters exist in situations where available nesting sites are a limiting factor. At LLC, we observe that essentially all nest boxes are actively used every year. Also, we occasionally capture more than two adults at an active nest box. Such "extra" adults likely indicate the existence of floaters within the population.

We do not know the extent of the floater population. Various discussions within this report have assumed a low (insignificant) proportion of floaters. But, we can also speculate on how a significant population of floaters would change our perspective of what is going on at LLC.

Let's discuss a hypothetical situation with a significant level of floaters at LLC. Floaters would likely be highly motivated to engage in behaviors that may result in an opportunity for them to directly, or indirectly, participate in breeding.

For example, floaters may attempt to enter currently active nest boxes to either attempt mating (stolen copulations) with an individual, already a parent of the current nesting attempt, or do something to cause failure of the current nesting attempt.

Stolen copulations may afford a floater a way to contribute their genetic material into a nesting attempt that may be supported by a pair of other [possibly unsuspecting] adults. A nesting failure may result in a nest box becoming available, possibly giving the floater an opportunity to nest. Observed captures of "extra" adults [beyond the suspected parental pair] may represent floater intrusions.

Academic ornithological research of floaters often suggests that if a floater is genetically related to extant eggs or nestlings, the floater may assist with parental care during nesting and is referred to as a 'helper'. Likewise, if a floater is not genetically related, the floater may attempt to hinder the success of nesting.

How might a significant floater population relate to patterns of events we have observed at LLC? We have captured, at nest boxes, many [unbanded] adults. We band these with both aluminum [silver] bands plus a unique color-coded band. We assign an age category "AHY" [after hatch year] as we can't determine their actual age.

What is the source of these individuals? There are a few possibilities:

1) they may have come from LLC during previous years, either as breeding adults that we had failed to catch [and band], or
2) they were [unbanded] floaters from previous years. or
3) they came from nesting areas other than LLC [where nestlings/adults were not consistently captured/banded].

It is possible that there is a significant level of unbanded floaters/breeders that return to LLC year-after-year.

We detect a number of individuals, at LLC, with just one band [an aluminum federal band and no colored band]. These are individuals that we have banded as nestlings in previous years. We only detect these when they are captured in a nest box. Possibly there are other such individuals that are present but don't enter boxes. These would be [single-banded] floaters that may exist with other [non-banded] floaters at LLC and may even return, undetected, year after year.

The above discussions relate to a potential floater population of unknown size. What steps might be taken to better understand the existence of, and impact of, floaters at LLC? Genetic analysis of the suspected parental pair vs genetic make-up of nestlings may indicate the occurrence of stolen copulations [per floaters]. Additionally, an analysis of box visitations across large spans of time may afford a better judgement of which individuals are actual parents and if there are other [potential floaters] entering boxes.

The current approach essentially documents box visitations only during limited periods of capture/banding activities. If a system could be developed that would accurately log box visitations and [when possible] detail specific individuals, such would greatly enhance our understanding of parental vs non-parental activity at specific boxes. It should be possible to attach RFID tags to adults we capture and have a tag reader at box entry holes.

Furthermore, a sensor could be developed that would detect all box entries [whether or not by an individual having a RFID tag]. Detailed logs of box visitations would afford a complete picture of energy investment of individuals. Those with relatively high investments will likely belong to the parental pair. Those with lesser investments [very limited visitation rates] will likely be floaters. It would also be interesting to look for patterns of visitations associated with patterns of box disturbance by humans [box monitoring or capture/banding].

From our six years of monitoring and banding data, we can get an impression of the extent of the uncertainty introduced by floaters.

As we had 14 nest boxes in 2017 and 22 nest boxes for years 2018 to 2022 and the possibility for the TRES to have two nesting cycles per year, there were, overall, 248 nesting possibilities for the TRES, WEBL, and VGSW (the only other bird species to utilize the LLC nest boxes).

Referring to Fig. 9:

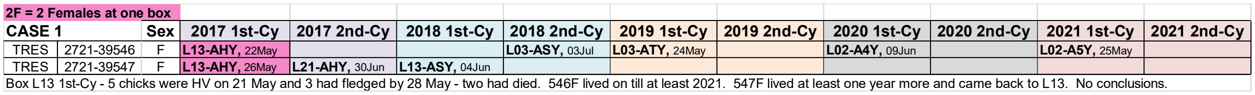
- 248 nesting possibilities:
- 167 were utilized by TRES
- 132 had one or more TRES adults captured
- 85 had two or more TRES adults captured
- 9 had either two Females (7) or one Male and two Females captured (2)

Again, referring to Fig. 9, it is readily apparent from the number of uncaptured (or potentially uncaptured) adults, that a significant floater population could exist undetected. On the other side of the discussion, the majority of monitored nests exhibited the normal nesting progression of 5 eggs laid, 5 hatched, and 3-to-5 lived to fledge (the overall TRES mortality rate for the six years was 35%); so, it appears, that in the case of LLC, the effect of floaters is not likely dominant.

Going into greater depth, the three cases below indicate some of the non-normal occurrences that we have encountered:

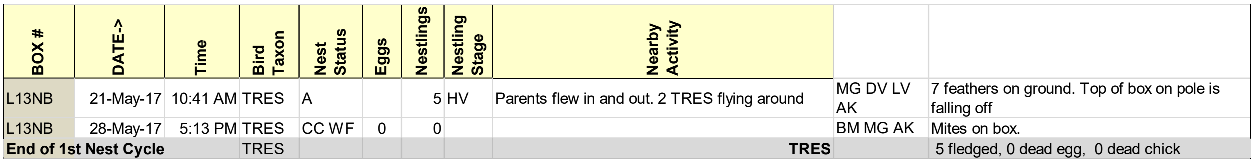
Case 1:

Banding Log for Case 1 – 2017-1st Nesting Cycle – Box L13



2F = 2 Females at one box												
CASE 1		**Sex**	**2017 1st-Cy**	**2017 2nd-Cy**	**2018 1st-Cy**	**2018 2nd-Cy**	**2019 1st-Cy**	**2019 2nd-Cy**	**2020 1st-Cy**	**2020 2nd-Cy**	**2021 1st-Cy**	**2021 2nd-Cy**
TRES	2721-39546	F	**L13-AHY,** 22May			**L03-ASY,** 03Jul	**L03-ATY,** 24May		**L02-A4Y,** 09Jun		**L02-A5Y,** 25May	
TRES	2721-39547	F	**L13-AHY,** 26May	**L21-AHY,** 30Jun	**L13-ASY,** 04Jun							
Box L13 1st-Cy - 5 chicks were HV on 21 May and 3 had fledged by 28 May - two had died. 546F lived on till at least 2021. 547F lived at least one year more and came back to L13. No conclusions.												

Monitoring Log for Case 1 – 2017-1st Nesting Cycle – Box L13



BOX #	DATE->	Time	Bird Taxon	Nest Status	Eggs	Nestlings	Nestling Stage	Nearby Activity		
L13NB	21-May-17	10:41 AM	TRES	A		5	HV	Parents flew in and out. 2 TRES flying around	MG DV LV AK	7 feathers on ground. Top of box on pole is falling off
L13NB	28-May-17	5:13 PM	TRES	CC WF	0	0			BM MG AK	Mites on box.
End of 1st Nest Cycle			TRES					**TRES**		5 fledged, 0 dead egg, 0 dead chick

Note: Under “Nestling Stage”, HV = Half-Vane.

On the 21st of May 2017, 5 HV nestlings were in box L13. Note that the HV designation for the nestlings is probably not accurate here; as the next day a more highly skilled evaluation is four BR and one QV (BR = Brush and QV = Quarter Vane) (See Appendix 7 for classification definitions.)

On the 22nd of May, female 2721-39546 was captured and banded. At that time, five nestlings were present – four BR and one QV. They were also banded: 2721-39541 to 545. It is noted that two other adults perched at hole but did not enter to be captured.

On the 26th of May, female 2721-39547 was captured and banded at Box L13. At this time, two nestlings were alive and three were dead [removed from nest box].

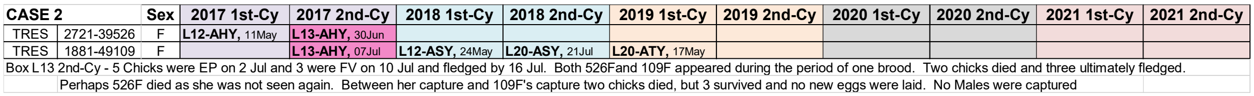
Note that female 2721-39546 is alive at this time, for she appears for the next four years.

So, it would seem that a floater took that opportunity to enter the box and was captured – either on the 22nd or the 26th, depending on whether 546 or 547 is considered the floater.

On the 28th of May, the nest box is empty – no living or dead nestlings. It is assumed that two had fledged. Consideration should be given to the possibility that a floater female (one of the two females captured) may have contributed to the partial failure of the brood.

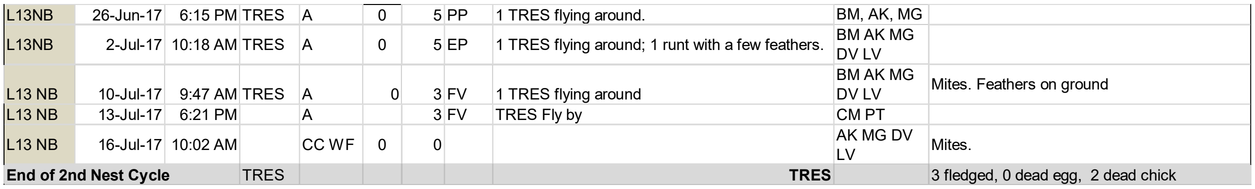
Case 2: We see that a 2nd nest was made at L13; however, by yet another female.

Banding Log for Case 2 – 2017-2nd Nesting Cycle – Box L13



CASE 2		Sex	2017 1st-Cy	2017 2nd-Cy	2018 1st-Cy	2018 2nd-Cy	2019 1st-Cy	2019 2nd-Cy	2020 1st-Cy	2020 2nd-Cy	2021 1st-Cy	2021 2nd-Cy
TRES	2721-39526	F	**L12-AHY,** 11May	**L13-AHY,** 30Jun								
TRES	1881-49109	F		**L13-AHY,** 07Jul	**L12-ASY,** 24May	**L20-ASY,** 21Jul	**L20-ATY,** 17May					
Box L13 2nd-Cy - 5 Chicks were EP on 2 Jul and 3 were FV on 10 Jul and fledged by 16 Jul. Both 526Fand 109F appeared during the period of one brood. Two chicks died and three ultimately fledged.												
	Perhaps 526F died as she was not seen again. Between her capture and 109F's capture two chicks died, but 3 survived and no new eggs were laid. No Males were captured											

Monitoring Log for Case 2 – 2017-2nd Nesting Cycle – Box L13



L13NB	26-Jun-17	6:15 PM	TRES	A	0	5	PP	1 TRES flying around.	BM, AK, MG	
L13NB	2-Jul-17	10:18 AM	TRES	A	0	5	EP	1 TRES flying around; 1 runt with a few feathers.	BM AK MG DV LV	
L13 NB	10-Jul-17	9:47 AM	TRES	A	0	3	FV	1 TRES flying around	BM AK MG DV LV	Mites. Feathers on ground
L13 NB	13-Jul-17	6:21 PM		A		3	FV	TRES Fly by	CM PT	
L13 NB	16-Jul-17	10:02 AM		CC WF	0	0			AK MG DV LV	Mites.
End of 2nd Nest Cycle			TRES					**TRES**		3 fledged, 0 dead egg, 2 dead chick

On the 26th of June 2017, box 13, five nestlings were in the PP (Pre-Pin) stage.

On the 30th June, female 2721-39526 was captured in the box.

On the 2nd of July, there are five EP (Early Pin) nestlings present.

On the 7th of July, female 1881-49109 was captured in the box.

On the 10th of July, three nestlings were FV (Full Vane) and presumably fledged subsequently.

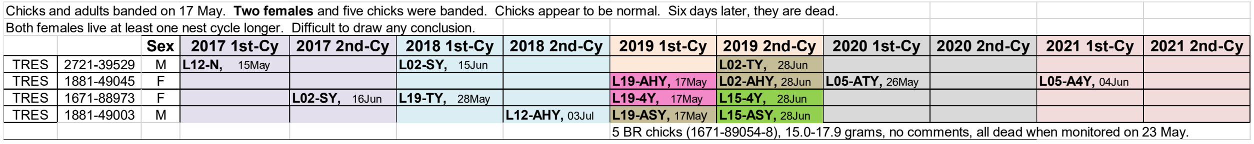
So, it would seem that one of the females was perhaps a floater and did not harm the nestlings.

It is complicated by the fact that we never saw the first female (2721-39526) again; so perhaps she died at this time, or later in the year; or just returned elsewhere or was here but not captured again. Difficult to say.

We continued seeing the second Female (1881-49109) for two more years.

Case 3:

Banding Log for Case 3 – 2019 1st Nest Cycle Box L19



Chicks and adults banded on 17 May. **Two females** and five chicks were banded. Chicks appear to be normal. Six days later, they are dead.												
Both females live at least one nest cycle longer. Difficult to draw any conclusion.												
		Sex	2017 1st-Cy	2017 2nd-Cy	2018 1st-Cy	2018 2nd-Cy	2019 1st-Cy	2019 2nd-Cy	2020 1st-Cy	2020 2nd-Cy	2021 1st-Cy	2021 2nd-Cy
TRES	2721-39529	M	**L12-N,** 15May		**L02-SY,** 15Jun			**L02-TY,** 28Jun				
TRES	1881-49045	F					**L19-AHY,** 17May	**L02-AHY,** 28Jun	**L05-ATY,** 26May		**L05-A4Y,** 04Jun	
TRES	1671-88973	F		**L02-SY,** 16Jun	**L19-TY,** 28May		**L19-4Y,** 17May	**L15-4Y,** 28Jun				
TRES	1881-49003	M				**L12-AHY,** 03Jul	**L19-ASY,** 17May	**L15-ASY,** 28Jun				
							5 BR chicks (1671-89054-8), 15.0-17.9 grams, no comments, all dead when monitored on 23 May.					

Monitoring Log for Case 3 – 2019 1st Nest Cycle Box L19

	16-May	10:04	TRES	A	0	5	QV		Chirps from inside box	
	21-May	18:21	TRES	A						
L19	23-May	9:45	TRES	A	0	Dead	HV		5 DEAD	5 Dead- all banded

On the 16th of May 2019, box 19, five QV (Quarter Vane) nestlings were alive and chirping.

On the 17th of May, both female 1881-49045 and female 1671-88973 were captured and the nestlings were banded.

On the 23rd of May, all the nestlings were dead, even though they had been normal and apparently healthy six days previously.

A different female 1881-49004 was associated with this nest box and produced a successful brood (5 fledges) in the 2nd nest cycle of 2019.

Perhaps female 1881-49045 or female 1671-88973 caused the mortality of the first brood in an [unsuccessful] attempt to take over the nest; or perhaps the nestlings died of some disease or parasites (although it generally it takes them longer to die from parasites (mites).

While it is unclear as to the details in the three cases, it does seem clear that multiple females can be associated with an active nesting cycle. The prevalence of this kind of event is uncertain and may not be significantly high with regard to the general trends we are observing. In general, mated pairs may successively exclude floaters from their nest boxes – just not all the time. We attempt to keep any floaters out of nest boxes, by blocking box entrance holes, during periods that both suspected adults are temporarily detained during their banding process.

APPENDIX 3
Sustainability Index (SI)

Development of the Concept and Calculations

Concept:

Generally, a species will be sustainable, in a given region, when it's adults produce sufficient viable offspring to replace these adults in their offspring's lifetime.

To determine this, we first need to estimate what the average lifespan of the adults is; then we need to know how many adults were involved in producing the offspring; then we need to know how many of their offspring came back to reproduce.

1. **Average lifespan of an adult in the wild**
2. **How many adults were involved in producing offspring**
3. **How many of their offspring survived to reproduce.**

AWLS (Average Wild Lifespan) of an Adult TRES

Determining AWLS

The **AWLS** is determined from an edited version of the Mating Chart, Fig. AP3a.

First, all the birds, only seen once and designated 'AHY' (After Hatch Year) were edited out; as their actual age was too nebulous; especially as they were only seen once.

Second, all the birds captured for the first time after 2019 were ignored as none of them could be specified as greater than three years-old; which would skew the estimated average age below what is likely the true average.

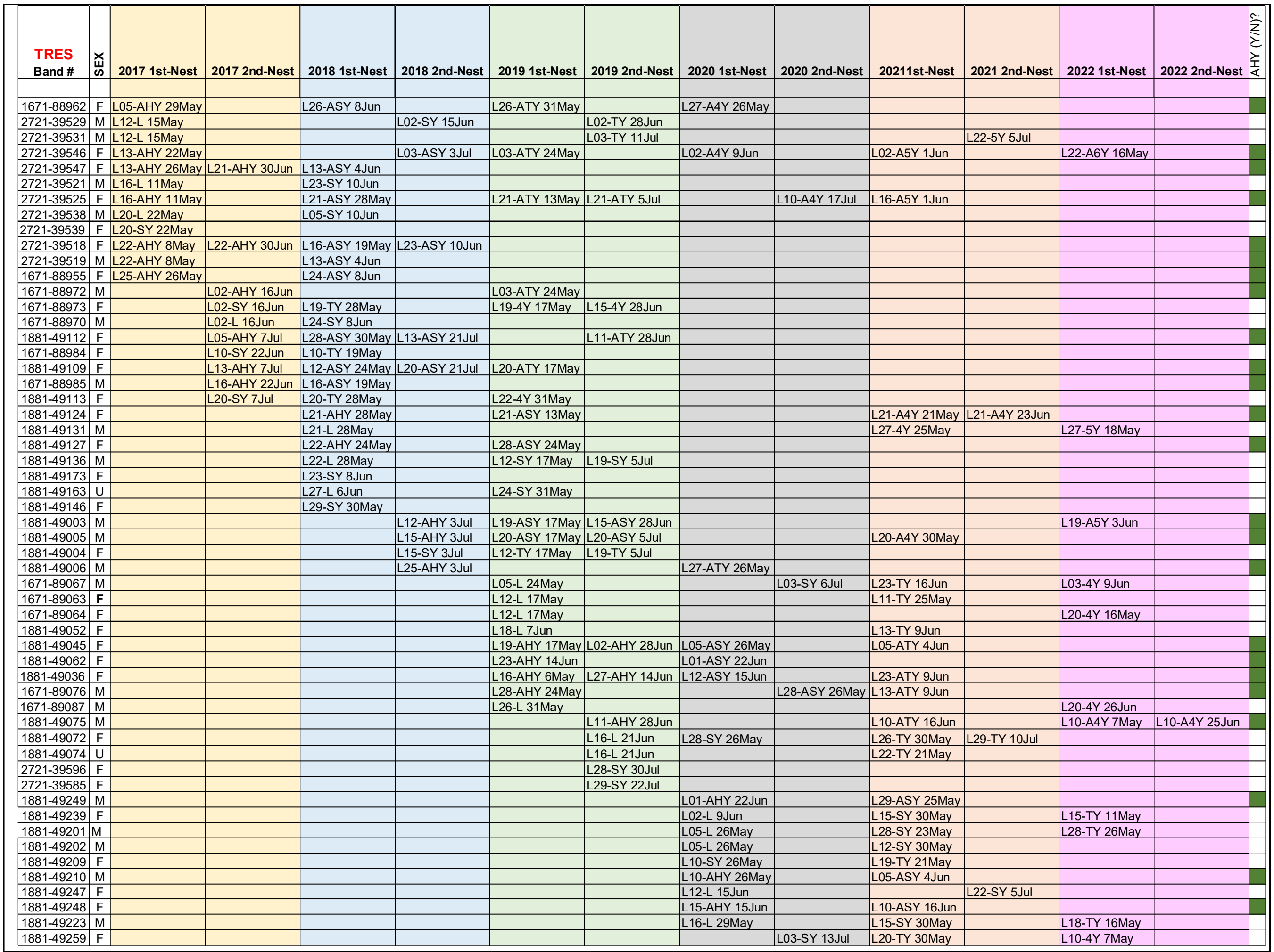
Third, a table was created, recording what the minimum age for the bird would be as of its last record. NOTE: It is important to realize that when a bird is designated, say, 'SY' (Second Year), it is only one-year-old and just beginning its second year. It is not two years-old.

Fourth, as the designation 'AHY' can mean the bird is anything from one-year-old to the species' maximum age, it is something of a wildcard. We believe it is significantly too conservative to assign AHY = one year old (or 'SY'), given that the AWLS of the TRES seems to be around 3.5 years on average for our area. So, we designated AHY = three years-old (and this was consistent with a sensitivity analysis reported below).

Assuming a Gaussian distribution of lifespans, we varied the age assigned to AHY birds from 1 to 5 years and observed how the data presented itself and its sensitivity to AHY variation.

If the AHY assignment was too low, we would see the data clumped to the left. If it were too high, we would see a gap between the birds with known ages and the AHY-birds. If the AHY age assignment was appropriate, then the bulk of the data would be between the two extremes. We can observe this in Fig. AP3b.

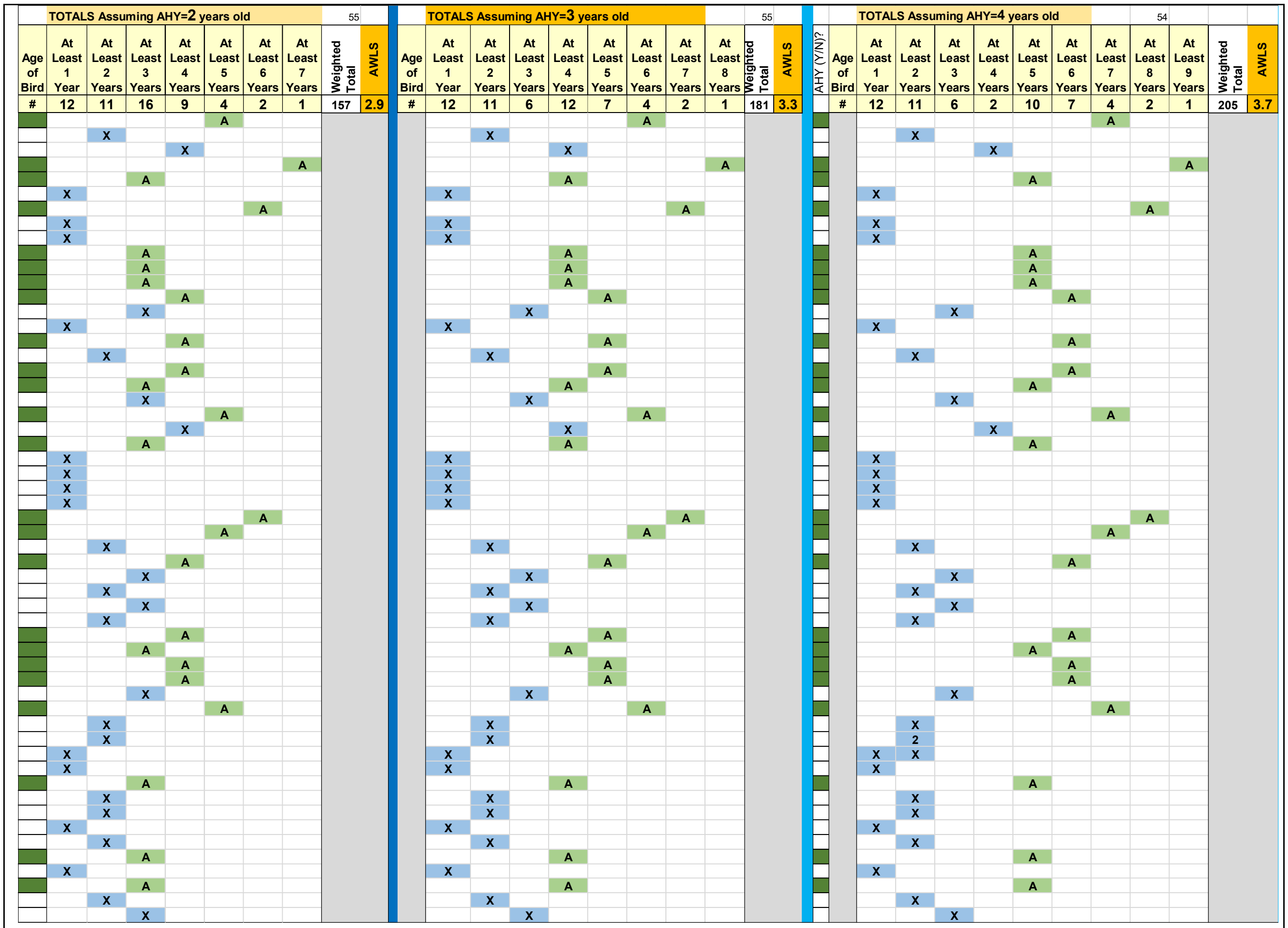
When tracking the same bird over the years, we can determine its minimum lifespan (It may have lived longer but either avoided capture or moved to another location). Fig. AP3a is the condensed banding data used for the AWLS determination. Fig. AP3b has the results for 3 guesses as to what AWLS might be (a sensitivity analysis). What we see is that for AHY = 2 years, the table of data is somewhat compacted to the left. For AHY = 3 years, there is a somewhat uniform distribution of data from 1 year to 7 years. And for AHY = 4 years, we see that the data has separated, with only one entry for 4 years. The reason that some of the data is shifting and some stays fixed is that for the birds fledged from LLC we know precisely for how long they have been returning and it is only the AHY data that shifts for different guesses of what AHY might be.



TRES Band #	SEX	2017 1st-Nest	2017 2nd-Nest	2018 1st-Nest	2018 2nd-Nest	2019 1st-Nest	2019 2nd-Nest	2020 1st-Nest	2020 2nd-Nest	20211st-Nest	2021 2nd-Nest	2022 1st-Nest	2022 2nd-Nest	AHY (Y/N)?
1671-88962	F	L05-AHY 29May		L26-ASY 8Jun		L26-ATY 31May		L27-A4Y 26May						🟩
2721-39529	M	L12-L 15May			L02-SY 15Jun		L02-TY 28Jun							
2721-39531	M	L12-L 15May					L03-TY 11Jul				L22-5Y 5Jul			
2721-39546	F	L13-AHY 22May			L03-ASY 3Jul	L03-ATY 24May		L02-A4Y 9Jun		L02-A5Y 1Jun		L22-A6Y 16May		🟩
2721-39547	F	L13-AHY 26May	L21-AHY 30Jun	L13-ASY 4Jun										🟩
2721-39521	M	L16-L 11May		L23-SY 10Jun										
2721-39525	F	L16-AHY 11May		L21-ASY 28May		L21-ATY 13May	L21-ATY 5Jul		L10-A4Y 17Jul	L16-A5Y 1Jun				🟩
2721-39538	M	L20-L 22May		L05-SY 10Jun										
2721-39539	F	L20-SY 22May												
2721-39518	F	L22-AHY 8May	L22-AHY 30Jun	L16-ASY 19May	L23-ASY 10Jun									🟩
2721-39519	M	L22-AHY 8May		L13-ASY 4Jun										🟩
1671-88955	F	L25-AHY 26May		L24-ASY 8Jun										🟩
1671-88972	M		L02-AHY 16Jun			L03-ATY 24May								🟩
1671-88973	F		L02-SY 16Jun	L19-TY 28May		L19-4Y 17May	L15-4Y 28Jun							
1671-88970	M		L02-L 16Jun	L24-SY 8Jun										
1881-49112	F		L05-AHY 7Jul	L28-ASY 30May	L13-ASY 21Jul		L11-ATY 28Jun							🟩
1671-88984	F		L10-SY 22Jun	L10-TY 19May										
1881-49109	F		L13-AHY 7Jul	L12-ASY 24May	L20-ASY 21Jul	L20-ATY 17May								🟩
1671-88985	M		L16-AHY 22Jun	L16-ASY 19May										🟩
1881-49113	F		L20-SY 7Jul	L20-TY 28May		L22-4Y 31May								
1881-49124	F			L21-AHY 28May		L21-ASY 13May				L21-A4Y 21May	L21-A4Y 23Jun			🟩
1881-49131	M			L21-L 28May						L27-4Y 25May		L27-5Y 18May		
1881-49127	F			L22-AHY 24May		L28-ASY 24May								🟩
1881-49136	M			L22-L 28May		L12-SY 17May	L19-SY 5Jul							
1881-49173	F			L23-SY 8Jun										
1881-49163	U			L27-L 6Jun		L24-SY 31May								
1881-49146	F			L29-SY 30May										
1881-49003	M				L12-AHY 3Jul	L19-ASY 17May	L15-ASY 28Jun					L19-A5Y 3Jun		🟩
1881-49005	M				L15-AHY 3Jul	L20-ASY 17May	L20-ASY 5Jul			L20-A4Y 30May				🟩
1881-49004	F				L15-SY 3Jul	L12-TY 17May	L19-TY 5Jul							
1881-49006	M				L25-AHY 3Jul			L27-ATY 26May						🟩
1671-89067	M					L05-L 24May			L03-SY 6Jul	L23-TY 16Jun		L03-4Y 9Jun		
1671-89063	**F**					L12-L 17May				L11-TY 25May				
1671-89064	F					L12-L 17May						L20-4Y 16May		
1881-49052	F					L18-L 7Jun				L13-TY 9Jun				
1881-49045	F					L19-AHY 17May	L02-AHY 28Jun	L05-ASY 26May		L05-ATY 4Jun				🟩
1881-49062	F					L23-AHY 14Jun		L01-ASY 22Jun						🟩
1881-49036	F					L16-AHY 6May	L27-AHY 14Jun	L12-ASY 15Jun		L23-ATY 9Jun				🟩
1671-89076	M					L28-AHY 24May			L28-ASY 26May	L13-ATY 9Jun				🟩
1671-89087	M					L26-L 31May						L20-4Y 26Jun		
1881-49075	M						L11-AHY 28Jun			L10-ATY 16Jun		L10-A4Y 7May	L10-A4Y 25Jun	🟩
1881-49072	F						L16-L 21Jun	L28-SY 26May		L26-TY 30May	L29-TY 10Jul			
1881-49074	U						L16-L 21Jun			L22-TY 21May				
2721-39596	F						L28-SY 30Jul							
2721-39585	F						L29-SY 22Jul							
1881-49249	M							L01-AHY 22Jun		L29-ASY 25May				🟩
1881-49239	F							L02-L 9Jun		L15-SY 30May		L15-TY 11May		
1881-49201	M							L05-L 26May		L28-SY 23May		L28-TY 26May		
1881-49202	M							L05-L 26May		L12-SY 30May				
1881-49209	F							L10-SY 26May		L19-TY 21May				
1881-49210	M							L10-AHY 26May		L05-ASY 4Jun				🟩
1881-49247	F							L12-L 15Jun			L22-SY 5Jul			
1881-49248	F							L15-AHY 15Jun		L10-ASY 16Jun				🟩
1881-49223	M							L16-L 29May		L15-SY 30May		L18-TY 16May		
1881-49259	F								L03-SY 13Jul	L20-TY 30May		L10-4Y 7May		

Fig. AP3a Condensed Mating Chart used to determine AWLS

TRES AWLS Sensitivity Analysis



	TOTALS Assuming AHY=2 years old							55	
Age of Bird	At Least 1 Year	At Least 2 Years	At Least 3 Years	At Least 4 Years	At Least 5 Years	At Least 6 Years	At Least 7 Years	Weighted Total	AWLS
#	12	11	16	9	4	2	1	157	2.9
🟩					A				
		X							
				X					
🟩							A		
🟩			A						
	X								
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			X						

	TOTALS Assuming AHY=3 years old								55	
Age of Bird	At Least 1 Year	At Least 2 Years	At Least 3 Years	At Least 4 Years	At Least 5 Years	At Least 6 Years	At Least 7 Years	At Least 8 Years	Weighted Total	AWLS
#	12	11	6	12	7	4	2	1	181	3.3
						A				
		X								
				X						
								A		
				A						
	X									
							A			
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				A						
		X								
		X								
	X									
		X								
				A						
	X									
				A						
		X								
			X							

		TOTALS Assuming AHY=4 years old							54			
AHY (Y/N)?	Age of Bird	At Least 1 Year	At Least 2 Years	At Least 3 Years	At Least 4 Years	At Least 5 Years	At Least 6 Years	At Least 7 Years	At Least 8 Years	At Least 9 Years	Weighted Total	AWLS
	#	12	11	6	2	10	7	4	2	1	205	3.7
🟩								A				
			X									
					X							
🟩										A		
🟩						A						
		X										
🟩									A			
		X										
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			X									
			2									
		X	X									
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🟩						A						
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		X										
			X									
🟩						A						
		X										
🟩						A						
			X									
				X								

Fig. AP3b AWLS for AHY = 2, 3, and 4 years

Note: The column of dark green squares on the right of Fig. AP3a and the left of Fig. AP3b denote adults designated 'AHY'.

They are useful for aligning the Fig. AP3a and Fig. AP3b. In addition, the cells in Fig AP3b that are highlighted in a lighter green denote AHY-birds. For example, the first row of Fig. AP3b contains the data for the adult TRES, 1671-88962 -F, designated 'AHY'. The row has a dark green square in the first column.

What we see first is that in assigning AHY to be 3 years, we obtain an AWLS of 3.3 years. So, our guess of 3 years is consistent with the result. Note that a guess of AHY=2 years results in an AWLS of 2.9 years; which is ***higher*** than the guess. A guess of AHY=3 years results in an AWLS of 3.3 years, closer to the guess, but still ***higher***. A guess of AHY=4 results in an AWLS of 3.7 years; which is ***lower*** than the guess.

When one combines this observation with the fact that the AHY data has visibly separated from the fixed data for AHY=4; it gives some confidence that giving the AHY-birds and age of 3 years is appropriate.

Consequently, using this measure we come to **AWLS = 3.3 years as a lower bound**.

We say “lower bound” because our methodology can only include the birds that we capture; and we capture only the birds that are both alive and physically fit enough to secure a mate and a nest box; thus, we do not see the birds that continue living but are no longer capable, or have gone elsewhere to nest; as well, the birds that have died.

Other factors in calculating SI

We need now to determine the number of adults that contributed to producing fledglings and the number of fledglings that returned. We use two rules in doing this:

1. The number of adult TRES occupying boxes. We do not discriminate on whether it is a 1st nest or a 2nd nest – just that two TRES created x-number of fledges in that box, in that year.

2. A box that had a WEBL couple the 1st nest cycle and a TRES couple the 2nd nest cycle is counted for both WEBL and TRES – as if it were two boxes.

Determining the number of TRES nestlings that returned in a particular year, given that we are unable to capture all of the adults.

We know, of the adult TRES we have captured in a given year, what percentage were returning birds from previous years and so, with that percentage and the total number of boxes occupied by the TRES, ***we can estimate how many returning birds we would have captured, had we been able to capture all of the adult TRES for that year.***

Determining the Number of Adults to Include:

We need to define the boundaries of our system; in this case, who to include as inside the system. Clearly, the captured adults are in the system; but which of the uncaptured adults to include?

At first, we might say that it is twice the number of active nest boxes; as they are a natural delineation of the geographical boundary of the system.

However, not all of the boxes are taken by TRES and sometimes they can be empty, especially for the 2nd nest cycle. There is also the question whether to lump the 1st and 2nd cycles together; or try to deal with them separately.

We have chosen to define the Total Possible Adult Population as ***twice the number of nests with TRES eggs*** *and* ***lumping the two nest cycles together***.

This, then gives us the total possible number of adults for a given year **(CA + UA)**, Captured Adults + Uncaptured Adults.

While (CA + UA) is a useful number, (which we will later use to extrapolate the number of **Fledged Returns, EFR**,) it will double-count the adults that were present for both nest cycles; and therefore, the number of fledglings needed to replace them.

An adult present for both nest cycles should only be counted once as only the one bird needs to be replaced by its offspring. Adjusting for this issue, we come to the metric - **Unique Captured Adults, UCA** (implemented as per rule 1), for the number of adults needing to be replaced. See Fig. AP3c.

Determining how many Offspring Survived to Reproduce

A bird captured at LLC will either have an aluminum band or not. If it has an aluminum band with one of our numbers, it is one of ours returning. If it does not have an aluminum band, it could be one of ours, fledged before we began banding, or it is coming as an adult for the first time to a nest box at LLC. So far, we have not captured a bird with a band from somewhere else.

So far, we have seen no other bands than the ones that we have placed. **However, the ones fledged elsewhere would not necessarily have a band**. What if the narrative that TRES were uncommon in the area before we placed the nest boxes is not correct? Then the uptick in numbers of TRES at LLC since we placed the nest boxes may only be that the nest boxes are perceived as superior habitat by the TRES; not that they are essential habitat for the TRES to breed in the area. See Appendix 5 for an expansion of this concept.

We only enter a nestling into the Mating database if we later see it as an adult. Out of the **27** captured during this study, **20** were captured the next year, **4** were captured in the 2nd year after fledging, and **3** were captured in the 3rd year after fledging.

Returned After Fledging			
One year later	Two Years Later	Three Years Later	Total Number
20	4	3	27

There could be two reasons for the delay in capture:

1. we were unable to capture the otherwise returned fledgling, or
2. the fledgling was initially out-competed for a nest box and remained nearby, nesting or not.

It could also be that a nestling returns but is never able to secure a nest box, yet manages to nest in the natural habitat nearby.

One should realize that due to the short time of the banding study, six years, that for the first three years of the study, some of the AHY-birds were some of our birds that had fledged before banding had begun; thus had no band.

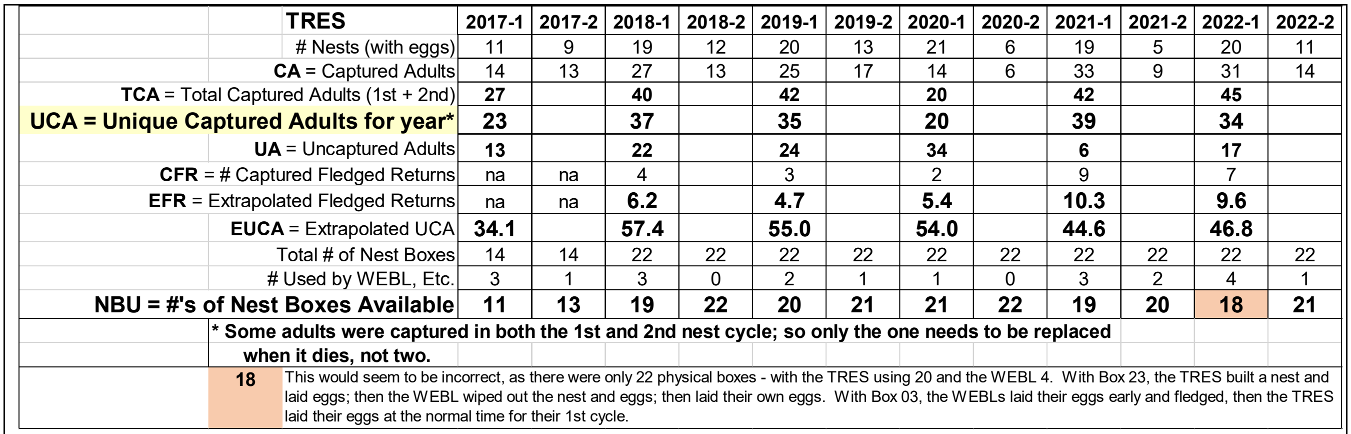
So, the practical reality, at present, of trying to determine the AWLS and SI is that the length of the study is still shorter than the lifespan of some of the TRES.

What we wish to achieve here is:

1. get some ball park values in order to better understand what the situation is and
2. create a conceptual framework so that, with more years of data, we can get closer to more representative values.

Calculation of SI:

Combining the results of the above selections into one table we get:



TRES	2017-1	2017-2	2018-1	2018-2	2019-1	2019-2	2020-1	2020-2	2021-1	2021-2	2022-1	2022-2
# Nests (with eggs)	11	9	19	12	20	13	21	6	19	5	20	11
CA = Captured Adults	14	13	27	13	25	17	14	6	33	9	31	14
TCA = Total Captured Adults (1st + 2nd)	**27**		**40**		**42**		**20**		**42**		**45**	
UCA = Unique Captured Adults for year*	**23**		**37**		**35**		**20**		**39**		**34**	
UA = Uncaptured Adults	**13**		**22**		**24**		**34**		**6**		**17**	
CFR = # Captured Fledged Returns	na	na	4		3		2		9		7	
EFR = Extrapolated Fledged Returns	na	na	**6.2**		**4.7**		**5.4**		**10.3**		**9.6**	
EUCA = Extrapolated UCA	**34.1**		**57.4**		**55.0**		**54.0**		**44.6**		**46.8**	
Total # of Nest Boxes	14	14	22	22	22	22	22	22	22	22	22	22
# Used by WEBL, Etc.	3	1	3	0	2	1	1	0	3	2	4	1
NBU = #'s of Nest Boxes Available	**11**	**13**	**19**	**22**	**20**	**21**	**21**	**22**	**19**	**20**	**18**	**21**

*** Some adults were captured in both the 1st and 2nd nest cycle; so only the one needs to be replaced when it dies, not two.**

18 This would seem to be incorrect, as there were only 22 physical boxes - with the TRES using 20 and the WEBL 4. With Box 23, the TRES built a nest and laid eggs; then the WEBL wiped out the nest and eggs; then laid their own eggs. With Box 03, the WEBLs laid their eggs early and fledged, then the TRES laid their eggs at the normal time for their 1st cycle.

Fig. AP3c Tabulation of SI Related Results

Where:

UA (Uncaptured Adults) = (Twice the number of TRES nests with eggs) less the total of captured adults. This assumes that there are two adults associated with each nest that has eggs. And it ignores any contribution by ‘floaters’.

CFR (Captured Fledged Returns) – A captured adult with just a single, aluminum band, previously last seen as a nestling.

EFR (Extrapolated Fledged Return) – Uses the ratio of captured adults to the total number of adults involved to estimate the total number of Fledged Returns that we would have had if we had captured all of the adults.

EUCA (Extrapolated Unique Captured Adults) – Similar concept as with EFR, only used with UCA.

NBU (Number of Nest Boxes Available) – The number of nest boxes available for the TRES, given that some nest boxes might be taken by WEBLs or VGSWs; and including for the rare instances where a nest box remains empty for the entire season.

Given the above, we are finally able to make some approximation of the general sustainability of the system, SI (Sustainability Index).

$SI = (AWLS \times EFR_n) / EUCA_{(n-1)}$ Where n = year

For example: for n = 2018, AHY=3, and AWLS=3.3

SI = (3.3 x 6.2) / 34.1 = 0.6

SI - 2018 to 2022	2017	2018	2019	2020	2021	2022	SI Ave.
AHY = 3 : AWLS = 3.3	na*	0.6	0.3	0.3	0.6	0.7	0.5
	* need to know # of parents from the previous year						

Fig. AP3d Sustainability Index for 2018 to 2021 at Lake Los Carneros

SI Sensitivity Analysis to AHY Age Specification

As most of the adult birds captured are being seen for the first time (54%), and because it is difficult to determine the age for unbanded adult Tree Swallows, they are assigned the age specification of 'AHY' (After Hatch Year).

AHY is then used to derive AWLS, which is a critical component of the SI.

Sustainability Index (SI) Calculation

$SI_n = (AWLS \times EFR_n) / EUCA_{n-1}$ **where n = year**

AWLS = Average Wild Lifespan

EFR = Extrapolated Fledged Return

EUCA = Extrapolated Unique Captured Adult

AHY = "After Hatch Year" age designation at first capture. Can be from one to the greatest number of years that a Tree Swallow can live.

We would like to see how varying AHY from 2 years to 4 years affects the SI calculation.

$SI_n >= 1$ means the Fledged Returns v Adults Deaths were sustainable in year, n.

TRES

SI v AHY	2017	2018	2019	2020	2021	2022	SI Ave.
AHY = 2 : AWLS = 2.9	na*	0.5	0.2	0.3	0.5	0.6	0.4
AHY = 3 : AWLS = 3.3	na*	0.6	0.3	0.3	0.6	0.7	0.5
AHY = 4 : AWLS = 3.7	na*	0.7	0.3	0.4	0.7	0.8	0.6
	* need to know # of parents from the previous year						

Fig. AP3e Sustainability Index Sensitivity to AHY Specification

The above chart shows that doubling the specification for AHY from two to four years has only a minimal effect on the calculated SI.

This would indicate that, while the AHY specification has some significant effect on SI, the major effect lies somewhere else. ***Essentially that there are not enough fledged nestlings returning to replace the adults***.

A Different Viewpoint

It is interesting to look at a somewhat complex problem like this from a different point of view and see how the results compare.

We can simply look at the CFR (Captured Fledged Returns) as a percent of the UCA (Unique Captured Adults) and multiply it by the AWLS (Average Wild Lifespan).

CFR (Captured Fledged Returns) v UCA (Unique Captured Adults)

Year	2017		2018		2019		2020		2021		2022	
	CFR	UCA	CFR	UCA	CFR	UCA	CFR	UCA	CFR	UCA	CFR	UCA
	na	23	4	37	3	35	2	20	9	39	7	34
Percentage CFR	**na**		**11%**		**9%**		**10%**		**23%**		**21%**	

Fig. AP3f Percent Captured Fledged Returns v Unique Captured Adults

SI ~ (Percentage CFR) * (AWLS)

(% Captured Fledged Returns) X (Average Wild Lifespan)

Year	~SI 2017	~SI 2018	~SI 2019	~SI 2020	~SI 2021	~SI 2022	AVE ~SI
AHY = 2 : AWLS = 2.9	na	0.3	0.2	0.3	0.7	0.6	**0.4**
AHY = 3 : AWLS = 3.3	na	0.4	0.3	0.3	0.8	0.7	**0.5**
AHY = 4 : AWLS = 3.7	na	0.4	0.3	0.4	0.9	0.8	**0.5**

Fig. AP3g Percentage Captured Fledged Returns Times Average Wild LifeSpan.

Fig. AP3g tracks the SI values shown in Fig. AP3e very closely. Both indicate that even for what looks to be a high value for AHY (4 years), not enough birds, fledged at LLC, are returning to make up for the adults being lost to attrition and that at least twice as many fledglings need to return to LLC to make the TRES population at LLC sustainable.

There are however some mitigating considerations:

1. It may be that the returning fledglings are not so precisely targeted as to return only to LLC; and may have some wider range of returning possibilities. However, we might then have encountering birds banded at Laguna Blanca, a site 9 km to the East; although they have primarily WEBLs there, it remains that we have not seen any of their WEBLs at LLC either.

2. There are a relatively large number of AHY's that only show up for one nest cycle and then are never seen again. Is this evidence of a high death rate or a loose homing instinct, or what?
3. As the boxes are nearly always fully utilized for the 1st nest cycle, could it be that the TRES consider them 'prime real estate'; so that whoever can, nests in a nest box; while many of the rest can't find a viable nesting situation and do not nest – a significant cloud of floaters that could include individuals banded as nestlings but not yet recaptured?

APPENDIX 4

Population Distributions –
TRES – Year 2020

While interesting in and of itself, the population abundance data from eBird helps us to better develop our concept of a Sustainability Index, and the issues we have with the preponderance of TRES classified as 'AHY' (After Hatch Year), by allowing us to view the issue from a larger context.

Two issues are:

1 Too few fledglings are returning to LLC relative to the number of adults present to repopulate the TRES population, given the Average Wild Lifespan indicated. Have they died or diffused out to other locations?
2 A bit more than half of the newly captured adults have not been banded before and, consequently, are given the indeterminate age-classification, 'AHY' (After Hatch Year); additionally, many of these are only seen once and were, perhaps floaters momentarily making an appearance. This increases the uncertainty in determining the AWLS (Average Wild LifeSpan); which, in turn, increases the uncertainty in determining the SI (Sustainability Index), as, the AWLS is used in determining the SI.

The following maps show, in different scales, the annual TRES migrations from South to North and then from North to South. Santa Barbara and Goleta are both breeding and stop-over locations for the TRES as they go up and down the Pacific Flyway.

The San Juaquin Valley and the Salton Sea-Colorado River areas are the dominant TRES regions in California; with the Oxnard-Ventura area being significant. Whereas, Santa Barbara, and even Lake Cachuma are merely backwaters of TRES activity by comparison.

Within the environs of Goleta-Santa Barbara, besides Lake Los Carneros, significant concentrations of TRES are reported (to eBird) from Devereaux and Goleta Sloughs, Laguna Blanca Country Club, and Andree Clark Bird Refuge, dating back, in most cases, to before the beginnings of the Santa Barbara Audubon Society's nest box program.

Given then, the closeness of other suitable habitat and the demonstrated general ambivalence of the TRES to nesting consistently in the same location (nest box); that the newly returning, former fledglings are diffusing to other areas and TRES from other areas diffuse into Lake Los Carneros each year, is a distinct possibility.

In other words, our study area, Lake Los Carneros, is likely too small to accurately determine the SI.

In theory, it would seem that this could be solved by expanding the banding program to include the above areas; however, the implementation of such a program has been beyond our resources. Laguna Blanca Country Club, 7 km from LLC, has a bird banding program in place but the predominate bird there is the WEBL.

One issue with this explanation is that we have not seen any birds at Lake Los Carneros, TRES or WEBL, that were banded at the Laguna Blanca Site.

There are other possible scenarios. For example, it is possible that the TRES [subpopulations] reform each year at their wintering site; and return with their new group to whatever area the group goes to. Or life is just tougher for the TRES in our area, with a correspondingly higher mortality rate.

However, perhaps, enough new birds from other areas are still flowing into our area to maintain similar population levels from year-to-year and the nest boxes remain at full capacity as the TRES apparently view them as superior nesting sites; so, the nest boxes fill first.

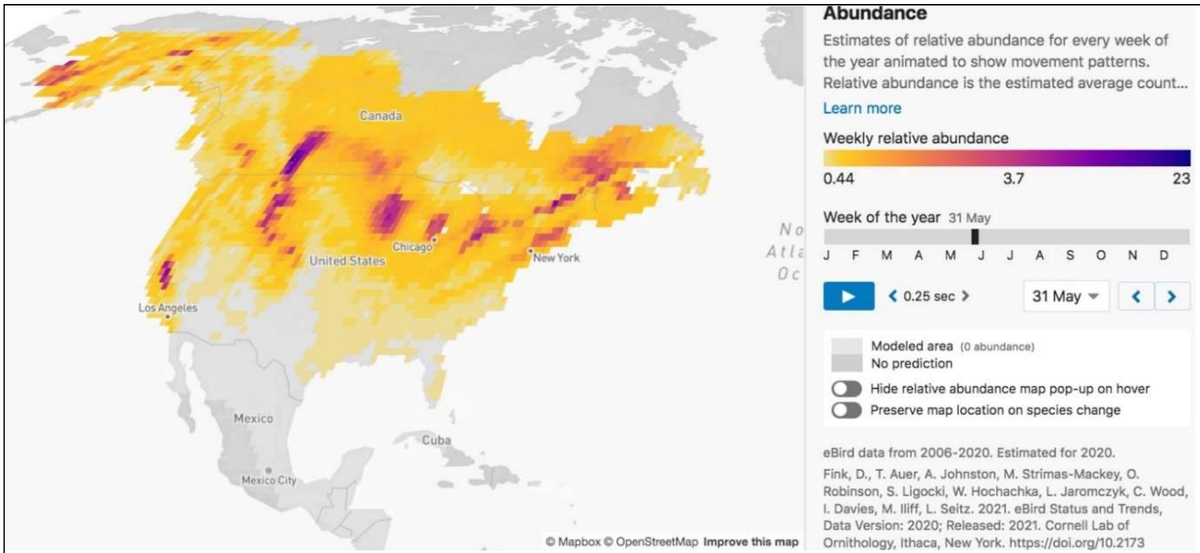
Or perhaps, there is a pool of floaters or uncaptured, particularly skittish adults, that we are momentarily encountering.

We do not know.

Maximum TRES Migratory Extents – 04 January and 31 May 2020

The following figures show the extent and timing of the TRES and WEBL populations throughout the year. Included, as a kind of control group are BLPH – a similar-sized, insect-eating, easily identified bird that is NOT a cavity nester. It nests under sheltering rocks, eves, etc.; therefore, not affected to first order by tree trimming and brush removal; thus allowing some reference comparison to the abundance of the TRES and WEBL.

eBird data from 2006-2020. Estimated for 2020



Abundance

Estimates of relative abundance for every week of the year animated to show movement patterns. Relative abundance is the estimated average count...

Weekly relative abundance

Week of the year 31 May

Modeled area (0 abundance)
No prediction

Hide relative abundance map pop-up on hover
Preserve map location on species change

eBird data from 2006-2020. Estimated for 2020.

Fink, D., T. Auer, A. Johnston, M. Strimas-Mackey, O. Robinson, S. Ligocki, W. Hochachka, L. Jaromczyk, C. Wood, I. Davies, M. Iliff, L. Seitz. 2021. eBird Status and Trends, Data Version: 2020; Released: 2021. Cornell Lab of Ornithology, Ithaca, New York. https://doi.org/10.2173

Fink, D., T. Auer, A. Johnston, M. Strimas-Mackey, O. Robinson, S. Ligocki, W. Hochachka, L. Jaromczyk, C. Wood, I. Davies, M. Iliff, L. Seitz. 2021. eBird Status and Trends, Data Version: 2020; Released: 2021. Cornell Lab of Ornithology, Ithaca, New York.

Fig. AP5a TRES Relative Abundance. Maximum Northern Extent – 31 May

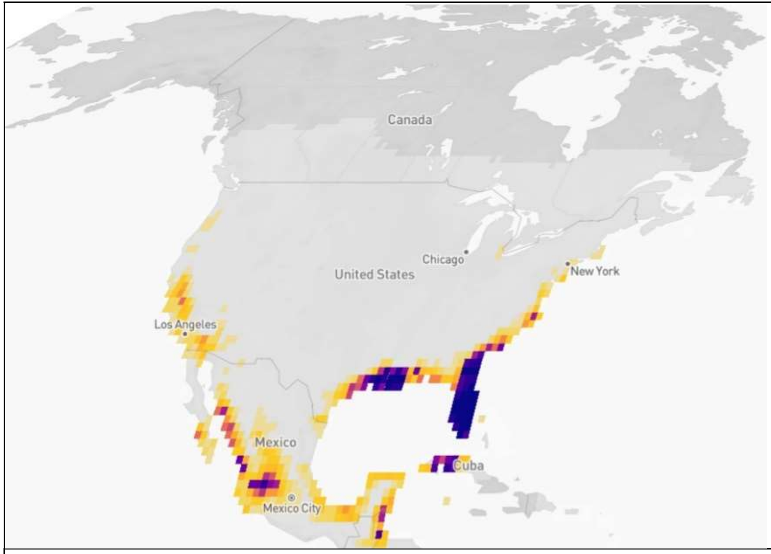


Fig. AP5b TRES Relative Abundance. Maximum Southern Extent – 04 Jan

The WEBL do not migrate, per se, but expand out a bit and then contract back.

WEBL Maximum Extents - October	**WEBL Minimum Extents - January**

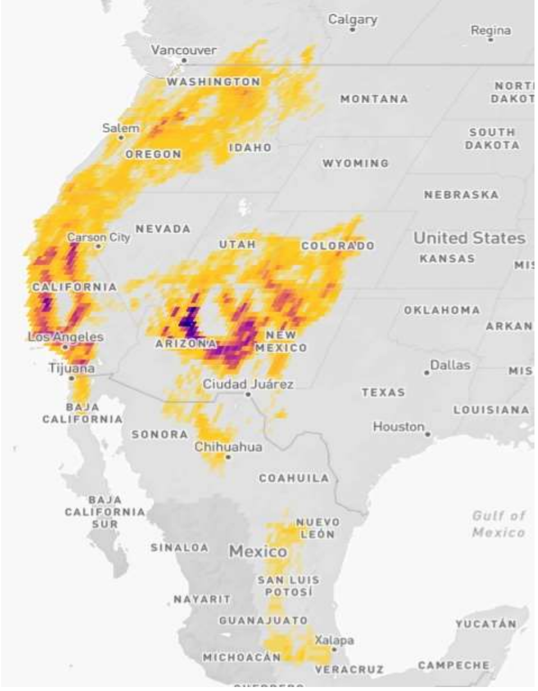
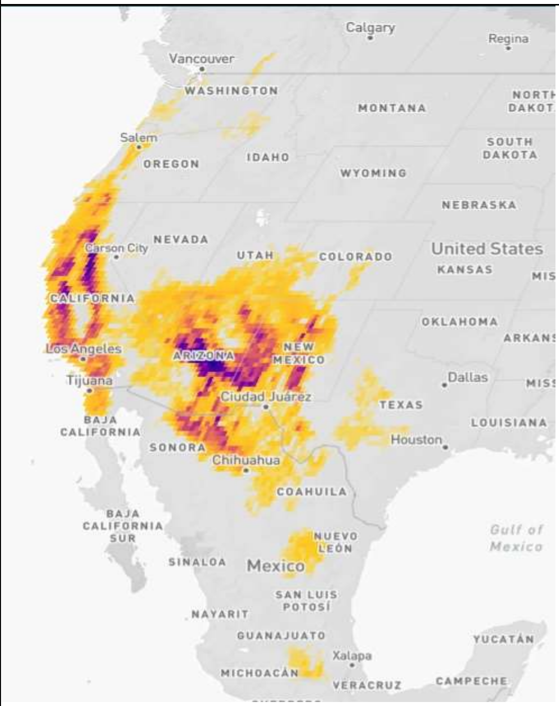

	

Fig. AP5c WEBL Relative Abundance. Maximum Extent	**WEBL Relative Abundance. Minimum Extent**

BLPH as a non-cavity-nesting reference comparison for the TRES and WEBL populations.

BLPH Maximum Extents - September	**BLPH Minimum Extents - January**

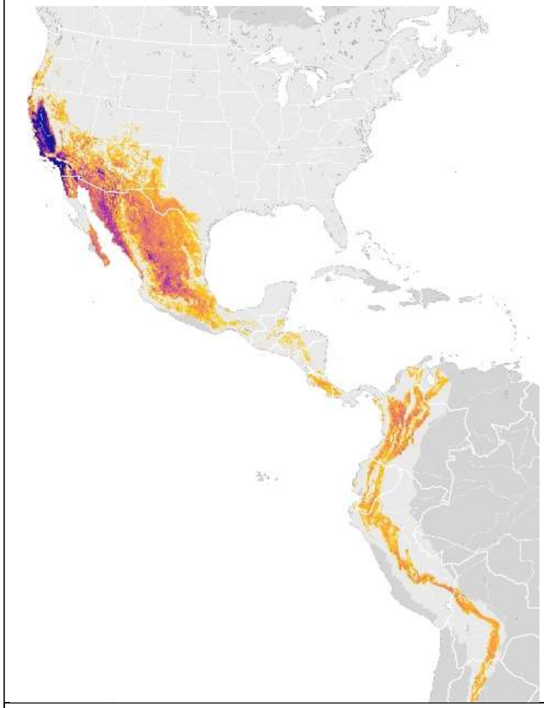
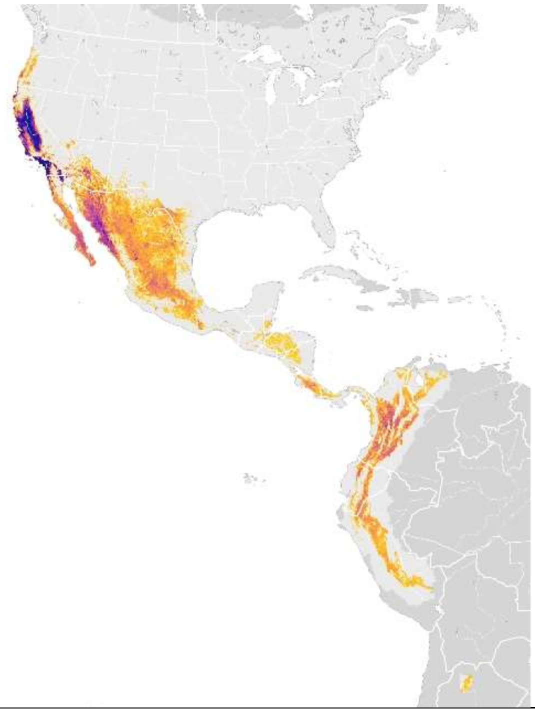
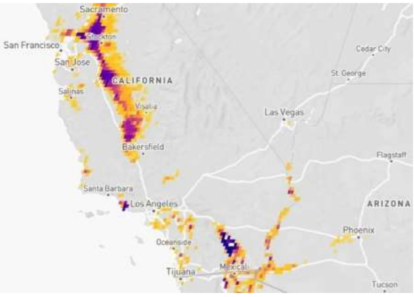
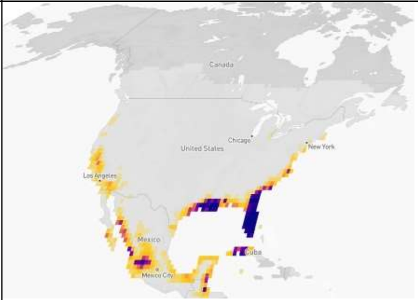
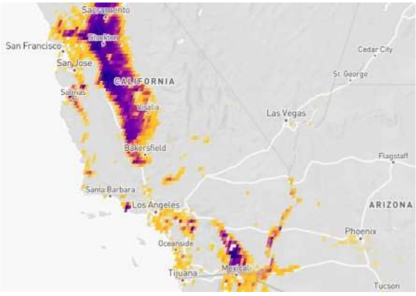
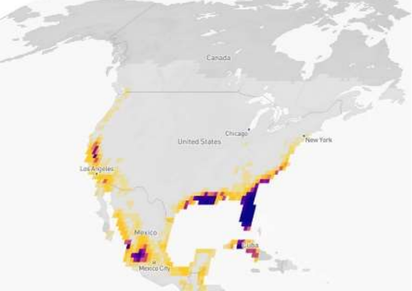
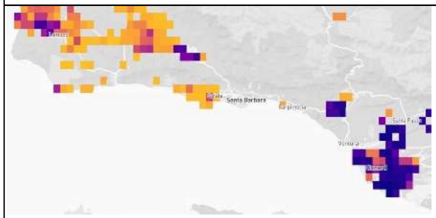
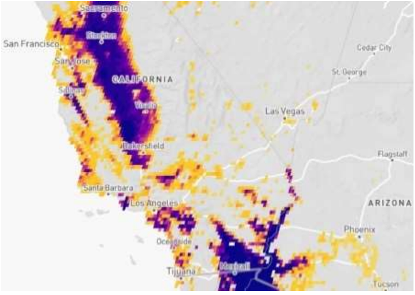
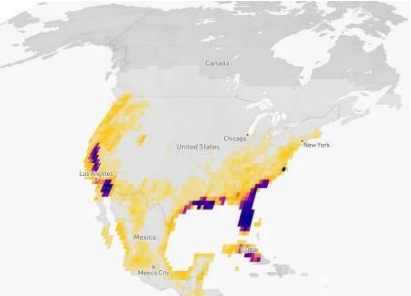
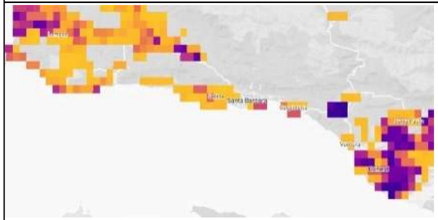
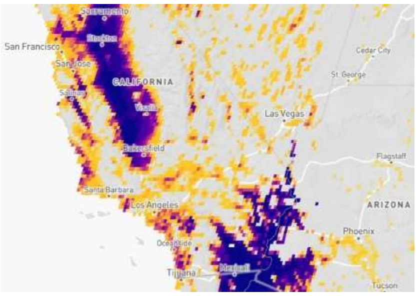
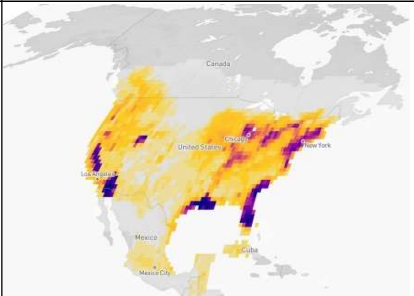
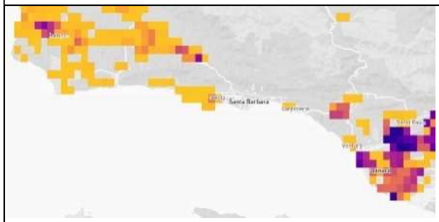
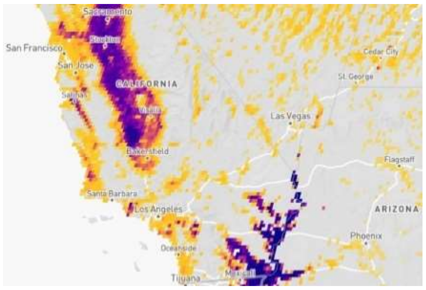
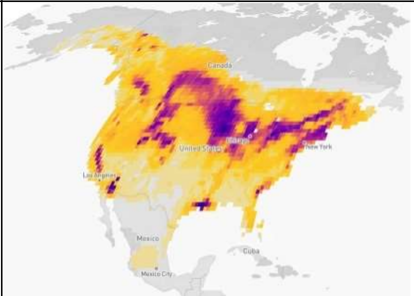

	

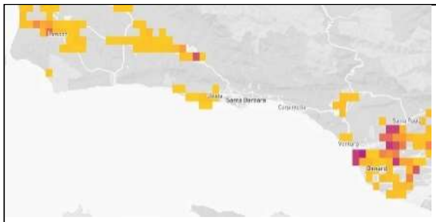
Fig. AP5d BLPH Relative Abundance. Maximum Extent	**BLPH Relative Abundance. Minimum Extent**

Below, the monthly change in population distribution for the TRES is given; as it changes significantly over time.

The WEBL and BLPH populations remain relatively static and the monthly variation is therefore not shown.

TRES Migration Pattern for 2020 (eBird) for Santa Barbara County, Southern California, and North America, month-by-month

S. B. County	So. California	North America
 TRES January 04	 TRES January 04	 TRES January 04
 TRES February 01	 TRES February 01	 TRES February 01
 TRES March 01	 TRES March 01	 TRES March 01
 TRES April 05	 TRES April 05	 TRES April 05
 TRES May 03	 TRES May 03	 TRES May 03



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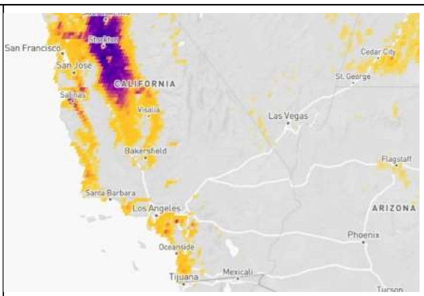

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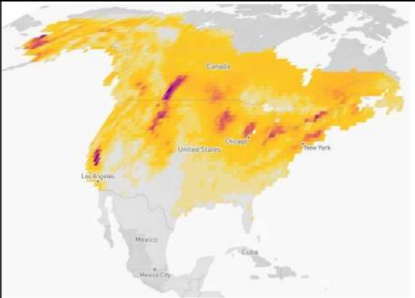

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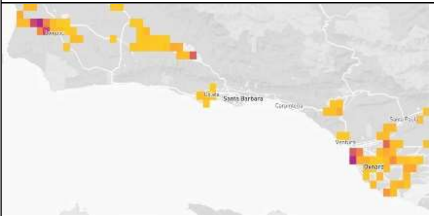

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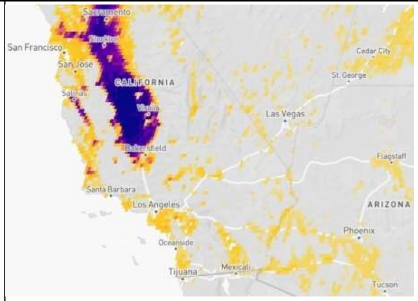

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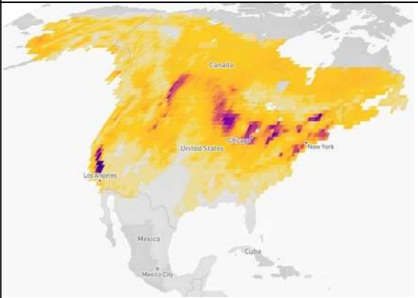

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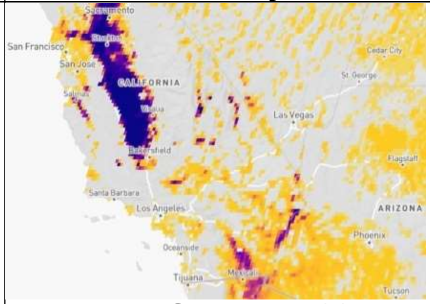

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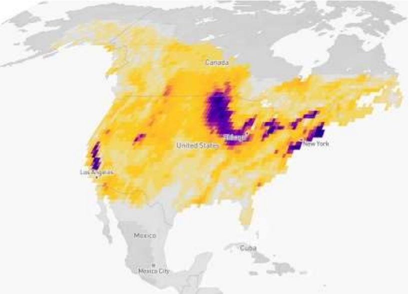

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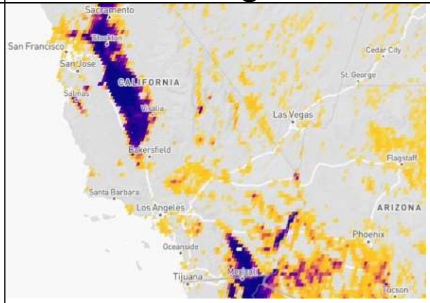

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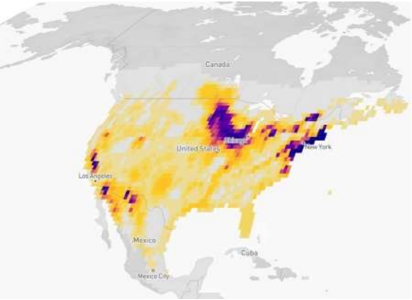

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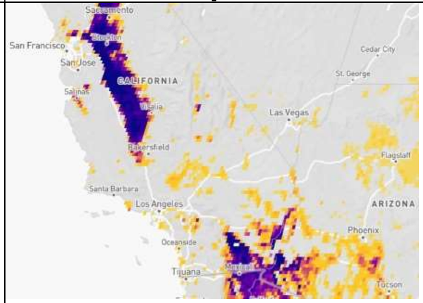


TRES October 05

TRES October 05

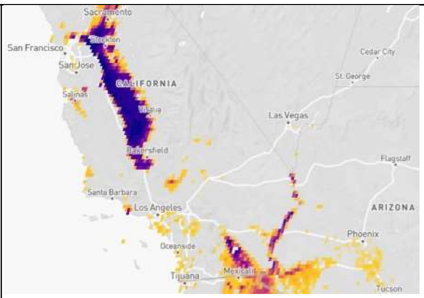
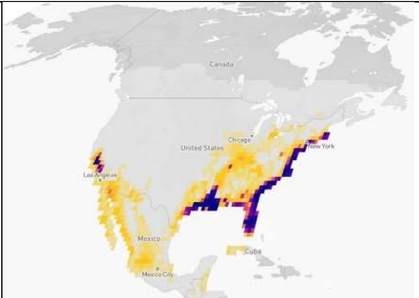
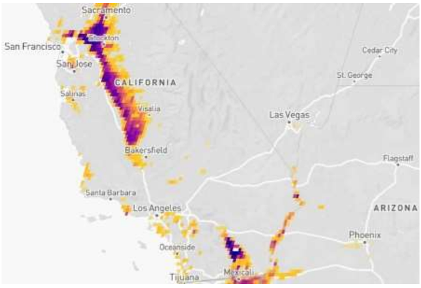
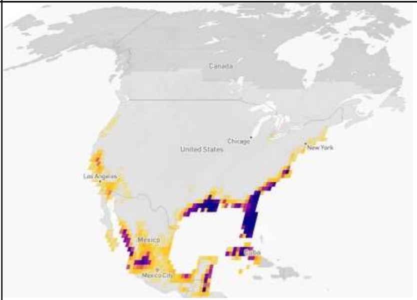
 **TRES November 02**	 **TRES November 02**	 **TRES November 02**
 **TRES December 07**	 **TRES December 07**	 **TRES December 07**

Fig. AP5e Comparison of TRES Abundance for Progressively Larger Areas

APPENDIX 5

Effects of Nest Boxes on TRES Population

In Santa Barbara County over the past twenty years.

Since the inception of our nest box program, the assumption has been that, due to tree trimming and land development which has resulted in a reduction of tree cavity nesting sites, the TRES population was reduced in this area.

The nest box program was begun as an effort provide more nesting sites for the TRES and perhaps reverse this trend. In compiling this report, we looked for a way to see how successful this effort was by utilizing eBird data, from 2005 to 2022, to look at the population trends for TRES and WEBL, using BLPH data as something of a reference.

Due to the fact that eBird was growing and changing over this period, and vagaries in how the data are presented, it was difficult to reach a definitive conclusion; however, there is a fairly strong indication that our nest boxes, while boosting the TRES population density at LLC, had little or no effect on the TRES population of the larger region, due to the relative small area affected by the program.

This indication comes in two parts:

1. From looking at eBird data from before our programs inception and in its early years, then comparing that with eBird data from the nest box program years.
2. Comparing the TRES and WEBL eBird data with that of the BLPH (Black Phoebe), a small, common, insect-eating, bird that builds its nests under overhangs, both natural and human-made.
3. Looking at eBird data from urban areas such as COPR (Coal Oil Point Reserve) area and LLC (Lake Los Carneros) and comparing that with data from around LCA (Lake Cachuma) – a mostly wilderness area (hence little tree-trimming and much less human interaction).

We looked at the number and distribution of sighting for TRES, WEBL, and BLPH (with BLPH acting as pseudo control group). As it is a relatively simple procedure and eBird data are available to all, interested parties may easily study whatever particular species, area, and relatively recent timeframe that may interest them.

There are various vagaries in the eBird data that make this a somewhat approximate, general comparison; although many times better than no information at all.

1. As eBird, is an on-line application that grew in popularity over the years of our interest, there are fewer entries for earlier years than later years, so, lower numbers of sightings in earlier years do not necessarily mean that there were fewer birds; but fewer observers reporting. We have somewhat compensated for this by normalizing the “# of birds counted” to the “# of reporting events” to get “Birds per Sighting”. Still, with fewer entries, there is more variance in data for the earlier years.

This is particularly egregious for the TRES at Lake Cachuma (LCA). For example, in 2016, out of 29 entries for the year, there were three entries, of 600, 315, and 100 individuals. Including these three entries gives an average of 48 individuals per sighting for the year, excluding them gives an average of 14 per sighting. Reducing them by half gives an average of 30.3 per sighting. In other words, because there are relatively few entries, the average is greatly affected by ‘outliers.”

This information does indicate that there were likely some large flocks of TRES migrating through the area on their way North. These data are somewhat consistent with the eBird migration data shown in Fig. AP5c; and there are some similar, but not as extreme, bulges of data in the January to March timeframe for some other years as well, that are not replicated for either WEBL or BLPH.

Again, the main issue is that more data points would be useful to illuminate these processes.

2. Many of the eBird entries are duplicates. eBird reports data from each individual reporting it; consequently, if a group of people, birding together, spot, say, 13 of a given species, eBird will report 13 of that species for each of the people reporting it. So, if there are five people reporting, eBird will imply that 65 of that species were seen, when likely it was only 13. We were able to remove the majority of these ‘duplicates’ using a simple formula in Excel. For example, at least **14% of the BLPH data for the Santa Barbara Region were found to be duplicates**.
3. While eBird is moderated, there is no certification system to evaluate whether a particular observation is coming from a highly competent birder, a moderately competent birder, or a beginner birder, so it can be hard to really trust some of the entries. However, in going into some of the entries in close detail, we feel that there are enough entries from birders that are known to be relatively expert in that they teach birding classes to the public, are respected members of Audubon, or have been associated with our local university, UCSB, to give a gravitas to simply accepting the eBird representation as some reasonable representation of reality.

We looked at the Santa Barbara Region, as a whole (Fig. AP6a), and LCA (Lake Cachuma) (FIG. AP5b), LLC (Lake Los Carneros) (FIG. AP5c), and COPR-NCOS (Coal Oil Point Reserve – North Campus Open Space) (FIG. AP5d) as sub-regions.

Again, we used eBird data for BLPH (Black Phoebe) as a comparison/control; as BLPH is not a cavity-nester; yet is a small insect-eating bird; somewhat constrained by similar parameters as the TRES or WEBL.

First, we graphed the “Average # of Birds per Sighting” by year from 2005 for the Santa Barbara Region as a whole; then for the three sub-regions: LCA, LLC, and COPR-NCOS. Note, that each of these regions covers a different-sized area. Because we have ***normalized*** these data to “Number of birds per Sighting” and are displaying the ***average***, this somewhat mitigates that issue; however, the smaller areas often do not have as many entries for the early years and this results in significant data-scatter in those early years, particularly for LLC and COPR-NCOS.

The "**Santa Barbara Region**" was selected to incorporate both urban and wilderness areas and to be relatively 'accessible' to the birds from our primary area of interest, LLC.

Santa Barbara Region: Latitude: 34.3930 to 34.6100 -120.0310 to -119.6340 **875 sqkm**

Fig. AP5a Santa Barbara Region with LCA, LLC, and COPR-NCOS sub-regions

LCA – Lake Cachuma: Latitude: 34.5320 to 34.5950 -119.7000 to -119.9870 **225 sqkm**

Fig. AP5b LCA – Lake Cachuma Region

LLC – Lake Los Carneros: Latitude 34.4380 to 34.4460 -119.8425 to -119.8550 **0.8 sqkm**

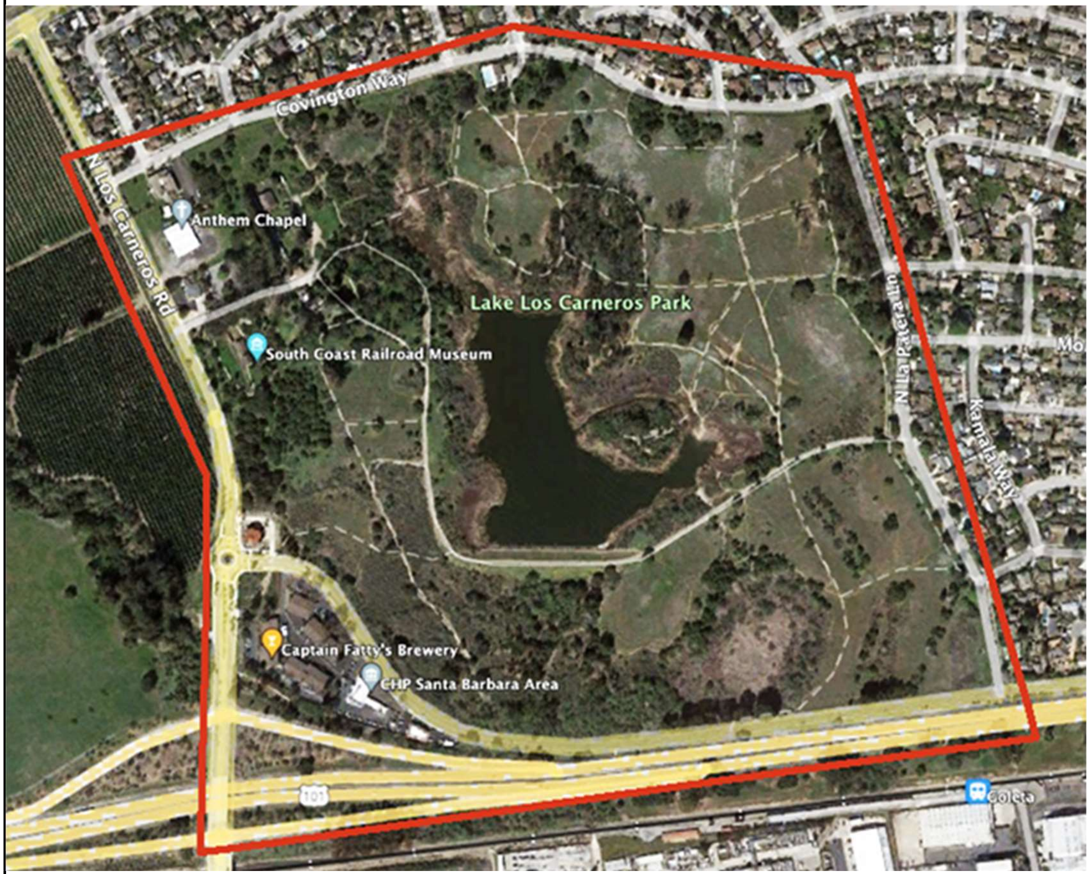


Fig. AP5c LLC – Lake Los Carneros Region

COPR-NCOS: Latitude 34.4070 to 34.4230 -119.8710 to -119.8910 **2.5 sqkm**

Fig. AP5d COPR-NCOS Region (Coal Oil Point Reserve & North Campus Open Space)

Number of <u>Bird Sightings</u> by Region and Sub-region: (eBird)

The Nest Box Program got started in Santa Barbara in 2005 as a way to increase the available nesting habitat for TRES in the Santa Barbara area. After some time, it became apparent that it was also serving a significant number of WEBL as well and that the differences between the two species would be useful to observe. In compiling this report, we felt that including BLPH (Black Phoebe) data would give a further reference for comparison; as the Black Phoebe, while being relatively similar in size and diet, are not cavity-nesters; rather they nest under overhangs, both natural and human-made.

During the period 2012-15, there were 11 nest boxes at Lake Los Carneros (LLC) and 20 nest boxes at Coal Oil Point Reserve (COPR).

From 2016-2017, LLC had 14 and COPR had 16 nest boxes; with some having been relocated to maximize fledging efficiency.

From 2017-2022, LLC had 22 and COPR had 0 (zero) nest boxes.

Some other dates of interest are:

Ocean Meadows Golf Course borders COPR to the North and was converted into its previously natural condition, becoming North Campus Open Space (NCOS). The irrigation of Ocean Meadows was discontinued near the end of 2013, associated with a sharp drop in the number of TRES fledging at COPR. One sees a tiny dip in the eBird data above, followed by a sharp jump in 2015. Whereas, the eBird WEBL sighting nearly double after 2013,

A second event, that one might expect to see mirrored in the eBird data was the removal of all of the nest boxes at COPR at the end of 2017. Again, one sees a drop in the TRES sightings in 2018, followed again by more than a full recovery. The WEBL sightings remained constant in 2018 then nearly doubled in 2019.

In part, these data are muddied by the fact that the Ocean Meadows – NCOS excavation began in 2017, when the area became a ‘moonscape’ for about one year. The final grading was completed in November 2017. The 136 Acres involved comprise about 20% of the area we have included as ‘COPR’ in this report. We do see drops in 2017 and 2018 for all three species. However, we also see drops in all other areas, except for LLC, in 2017; so, there could be some other factor(s), like weather, at play here.

The following tables give an indication of the prevalence of the three species in the Santa Barbara Region. This is modified generally by the fact that there are much less eBird entries for the earlier years than for the later years; as eBird slowly picked up members. A secondary influence on the numbers is that, for example, it is much more convenient for most birders to go to Lake Los Carneros or Coal Oil Point Reserve than to Lake Cachuma; consequently, there will tend to be fewer entries for Lake Cachuma.

TRES Year	SBR # of Sightings	LCA # of Sighting	LLC # of Sighting	COPR # of Sighting
< 2005	33	17	1	3
2005	9	1	0	6
2006	7	0	1	4
2007	15	1	1	8
2008	16	6	2	5
2009	14	2	3	2
2010	45	4	18	6
2011	46	8	23	6
2012	61	8	27	11
2013	67	6	30	19
2014	87	6	37	18
2015	183	15	52	89
2016	263	29	90	84
2017	246	12	119	72
2018	329	15	184	59
2019	348	25	127	88
2020	466	24	192	148
2021	491	20	272	63
2022	486	24	317	47
ALL Years	**3,212**	**223**	**1,496**	**738**

* 2022 Partial Year

WEBL Year	SBR # of Sightings	LCA # of Sightings	LLC # of Sightings	COPR # of Sightings
< 2005	218	31	4	19
2005	36	3	0	1
2006	42	2	1	2
2007	39	5	3	1
2008	172	16	2	1
2009	203	11	5	6
2010	333	10	8	17
2011	458	17	9	25
2012	514	15	20	22
2013	554	28	19	60
2014	578	22	22	102
2015	855	19	38	192
2016	1,016	50	54	234
2017	1,279	48	66	188
2018	2,036	63	121	189
2019	2,215	68	113	345
2020	2,874	80	271	423
2021	3,291	132	320	374
2022	2,034	103	236	294
ALL Years	**18,747**	**723**	**1,312**	**2,495**

* 2022 Partial Year

BLPH Year	SBR # of Sightings	LCA # of Sightings	LLC # of Sightings	COPR # of Sightings
< 2005	399	43	19	67
2005	85	2	1	10
2006	130	2	11	12
2007	200	7	17	35
2008	187	13	17	32
2009	195	8	36	31
2010	358	11	54	60
2011	494	15	63	86
2012	744	14	102	126
2013	736	27	113	147
2014	989	28	114	198
2015	1,846	40	187	383
2016	2,027	76	260	445
2017	2,012	35	212	438
2018	2,452	76	391	352
2019	2,686	70	264	685
2020	3,951	102	418	953
2021	4,042	127	517	785
2022	2,458	75	304	537
ALL Years	**25,991**	**771**	**3,100**	**5,382**

* 2022 Partial Year

The number of sightings can be seen to be increasing each year. This is not due to increasing bird populations, but to eBird becoming increasingly popular as a way of inputting data and thus an increasing number of observation-events.

Also note that overall there were:
3,212 TRES sightings
18,747 WEBL sightings
25,991 BLPH sightings
This results in there being much more scatter in the TRES data and less in the BLPH data.

Fig. AP5e # of Sighting – Santa Barbara Region and Sub-Regions

Note: Within the largest rectangle are three smaller, bounded areas, the medium-sized rectangle Is LCA (Lake Cachuma) (225 sqkm), the smallest area is LLC (lake Los Carneros) (0.8 sqkm), and the remaining, somewhat trapezoidal area is COPR-NCOS (Coal Oil Point Reserve and North Campus Open Space – UCSB) (2.5 sqkm).

Despite the fact that LCA is at least 100x larger than the other two sub-regions it rapidly begins to have fewer reported sightings as eBird gains in popularity – more people are staying close to home and in easy-to-access areas. This is shown in Fig. AP5e.

Number of Birds per Sighting by Region and Sub-region:

To deal with the above issue of different numbers of observers affecting the numbers of birds seen; we have normalized the following by dividing the # of birds seen by the number of observers to get the # of birds seen per sighting - ***# per Sighting***.

The following chart and graph shows the Santa Barbara Region overall.

TRES - Santa Barbara Region		
TRES Year	**# per Sighting**	# of Sightings
< 2005	13.3	33
2005	9.4	9
2006	9.3	7
2007	5.4	15
2008	9.1	16
2009	9.3	14
2010	10.8	45
2011	13.9	46
2012	11.6	61
2013	10.2	67
2014	9.5	87
2015	4.6	183
2016	12.5	263
2017	6.3	246
2018	8.5	329
2019	7.8	348
2020	7.5	466
2021	7.5	491
2022	8.0	486
ALL Years	**8.2**	**3,212**
* 2022 Partial Year		

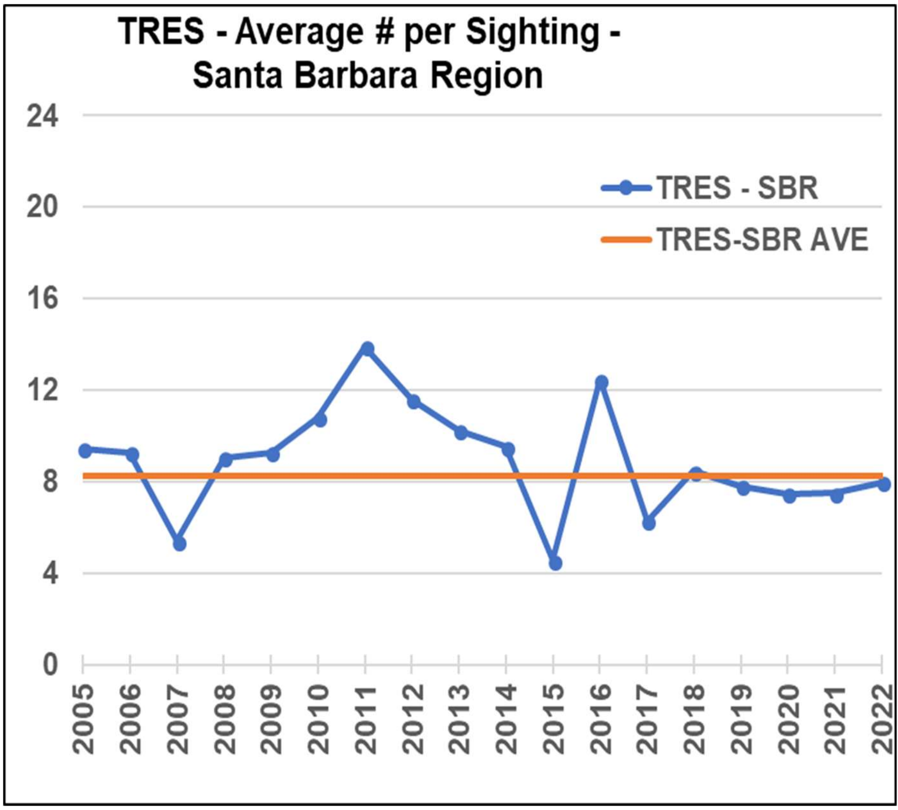


Fig. AP5f # of TRES per Sighting – Santa Barbara Region, with Overall Average indicated

In trying to trying to gain insight into whether TRES numbers are increasing or not, particularly with respect to Lake Los Carneros (LLC), we have used eBird data to work out roughly how many TRES are seen each time they are noted in eBird over the years compared to the number of WEBL and BLPH sightings. In part, because TRES are seen much less (3,200 times) than either the WEBL(18,750 times) or BLPH (26,000 times), there is much more volatility in the TRES data.

However, ***it does appear the TRES are exhibiting a downward trend in terms of population, # per sighting.***

TRES - # of Sightings by Year and Location				
TRES Year	**SBR # of Sightings**	**LCA # of Sighting**	**LLC # of Sighting**	**COPR # of Sighting**
< 2005	33	17	1	3
2005	9	1	0	6
2006	7	0	1	4
2007	15	1	1	8
2008	16	6	2	5
2009	14	2	3	2
2010	45	4	18	6
2011	46	8	23	6
2012	61	8	27	11
2013	67	6	30	19
2014	87	6	37	18
2015	183	15	52	89
2016	263	29	90	84
2017	246	12	119	72
2018	329	15	184	59
2019	348	25	127	88
2020	466	24	192	148
2021	491	20	272	63
2022	486	24	317	47
ALL Years	**3,212**	**223**	**1,496**	**738**

* 2022 Partial Year

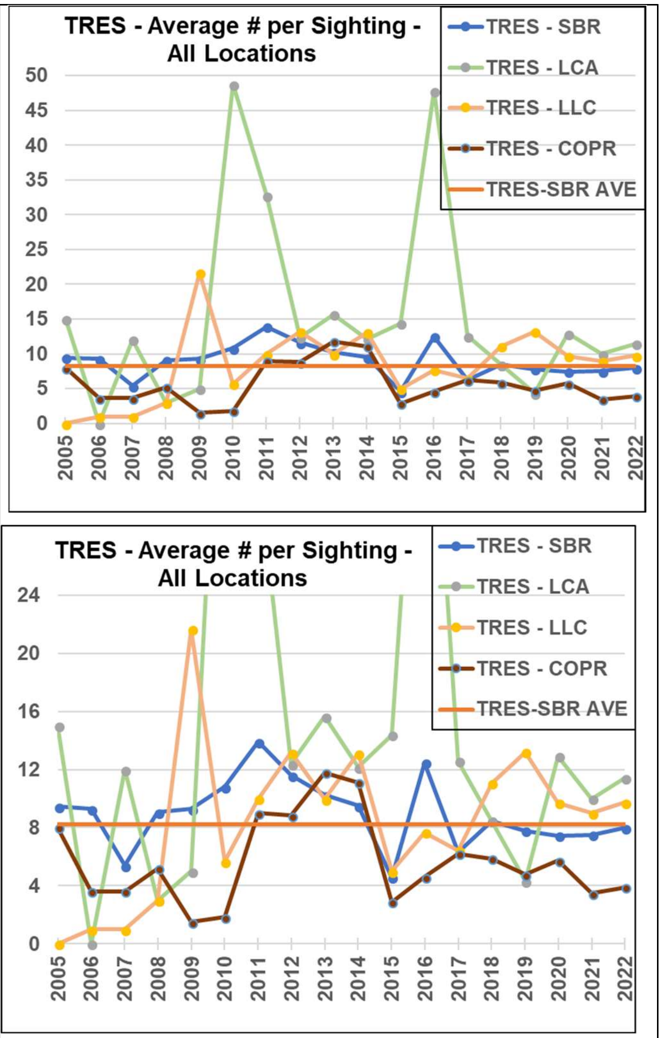


Fig. AP5g # of TRES Sightings – by Year and Location – indicating increased volatility corresponding to fewer sightings

Santa Barbara Region- SBR

WEBL Year	# of Sightings	# per Sighting
< 2005	218	5.0
2005	36	3.7
2006	42	3.4
2007	39	4.1
2008	172	8.4
2009	203	6.7
2010	333	6.7
2011	458	5.5
2012	514	5.7
2013	554	4.9
2014	578	3.4
2015	855	4.3
2016	1,016	4.6
2017	1,279	5.1
2018	2,036	4.5
2019	2,215	4.3
2020	2,874	4.1
2021	3,291	4.3
2022	2,034	3.7
ALL Years	**18,747**	**4.5**
* 2022 Partial Year		

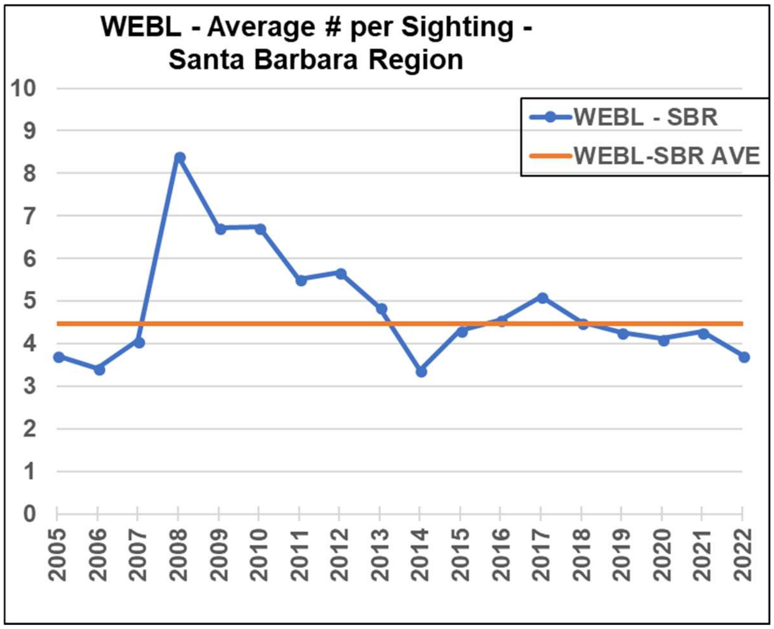


Fig. AP5h # of WEBL per Sighting – Santa Barbara Region, with Overall Average indicated

WEBL Year	SBR # per Sighting	LCA # per Sighting	LLC # per Sighting	COPR # per Sighting	ALL AVE
< 2005	5.0	6.8	1.5	6.1	4.5
2005	3.7	3.3	0.0	8.0	4.5
2006	3.4	5.0	1.0	1.5	4.5
2007	4.1	4.2	1.7	7.0	4.5
2008	8.4	3.6	3.0	2.0	4.5
2009	6.7	6.5	1.6	3.8	4.5
2010	6.7	5.0	1.5	3.4	4.5
2011	5.5	7.7	4.7	2.1	4.5
2012	5.7	3.2	2.9	2.6	4.5
2013	4.9	4.5	2.4	4.2	4.5
2014	3.4	4.7	2.5	4.5	4.5
2015	4.3	5.9	3.2	3.1	4.5
2016	4.6	4.4	2.6	3.7	4.5
2017	5.1	5.3	2.7	3.7	4.5
2018	4.5	5.7	3.4	3.0	4.5
2019	4.3	4.4	3.2	3.1	4.5
2020	4.1	4.9	3.1	2.5	4.5
2021	4.3	3.7	2.7	2.6	4.5
2022	3.7	3.3	2.6	2.8	4.5
ALL Years	**4.5**	**4.6**	**2.9**	**3.1**	
* 2022 Partial Year					

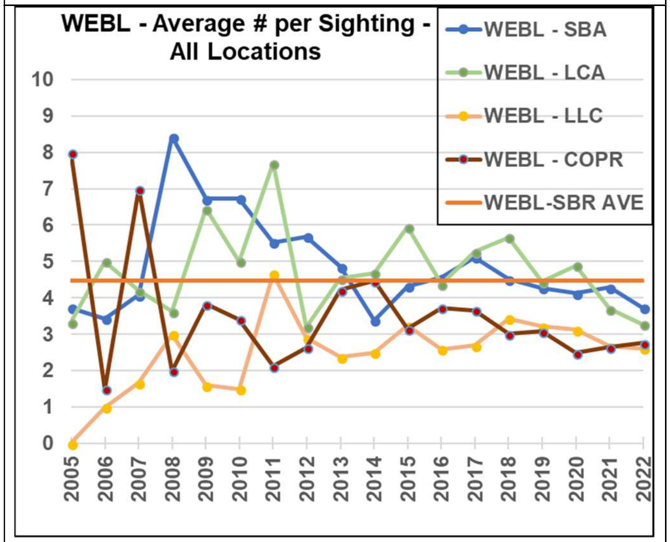


Fig. AP5i # of WEBL Sightings – by Year and Location – indicating increased volatility corresponding to fewer sightings

Santa Barbara Region- SBR

BLPH Year	**# of Sightings**	**# per Sighting**
< 2005	399	3.2
2005	85	3.2
2006	130	3.0
2007	200	2.4
2008	187	2.7
2009	195	2.6
2010	358	2.5
2011	494	2.5
2012	744	2.4
2013	736	2.2
2014	989	2.0
2015	1,846	2.0
2016	2,027	2.0
2017	2,012	2.0
2018	2,452	2.0
2019	2,686	1.9
2020	3,951	1.9
2021	4,042	1.7
2022	2,458	1.8
ALL Years	**26,009**	**2.0**

* 2022 Partial Year

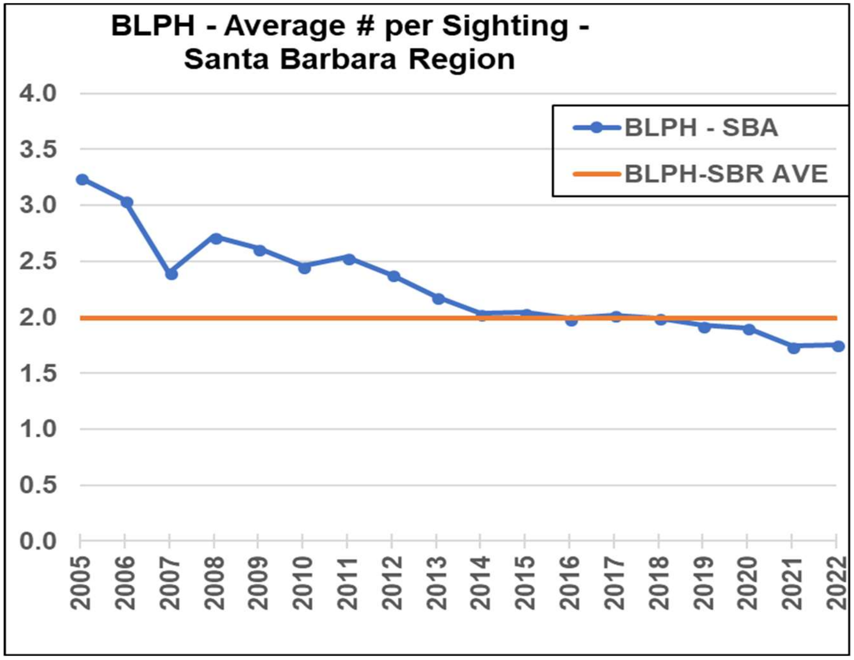


Fig. AP5k # of BLPH per Sighting – Santa Barbara Region, with Overall Average indicated

BLPH Year	**SBR # per Sighting**	**LCA # per Sighting**	**LLC # per Sighting**	**COPR # per Sighting**	**ALL AVE**
< 2005	3.2	3.5	2.2	4.3	2.0
2005	3.2	1.5	3.0	3.2	2.0
2006	3.0	1.0	3.8	3.0	2.0
2007	2.4	1.3	2.2	3.6	2.0
2008	2.7	1.6	3.2	2.1	2.0
2009	2.6	1.9	2.7	2.5	2.0
2010	2.5	2.5	2.7	2.7	2.0
2011	2.5	2.5	3.0	2.6	2.0
2012	2.4	1.4	3.1	2.5	2.0
2013	2.2	1.8	2.5	2.4	2.0
2014	2.0	1.9	2.4	2.5	2.0
2015	2.0	1.7	2.5	2.4	2.0
2016	2.0	1.6	2.0	2.4	2.0
2017	2.0	2.1	2.3	2.1	2.0
2018	2.0	1.9	2.1	2.3	2.0
2019	1.9	1.8	2.1	2.3	2.0
2020	1.9	2.2	2.1	2.2	2.0
2021	1.7	2.0	1.7	2.0	2.0
2022	1.8	2.0	1.8	2.2	2.0
ALL Years	2.0	2.0	1.8	2.3	

* 2022 Partial Year

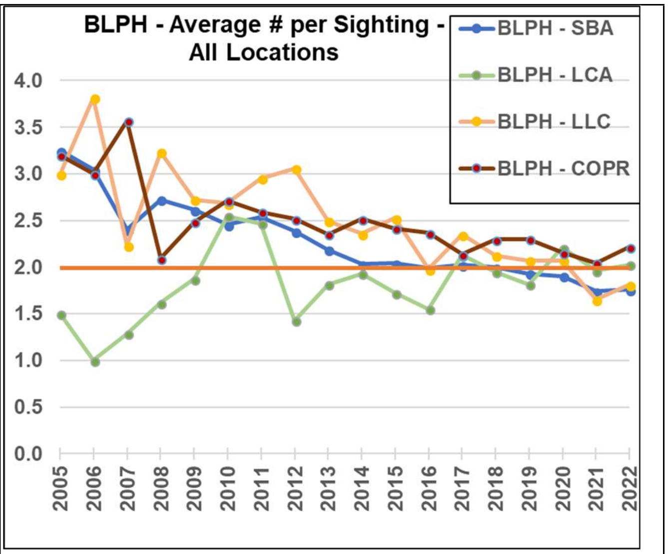


Fig. AP5L # of BLPH Sightings – by Year and Location

In the following figure, Fig. AP5m, we explore the possible effect of introducing nest boxes into a sub-region.

Before 2006, there were no TRES/WEBL nest boxes in the Santa Barbara region that we know of.

From 2006 to 2011(the gray years), we have no record of the number of nest boxes due to a data melt-down.

From 2012 to 2014 (the green years), there were roughly twice as many nest boxes at COPR as were at LLC.

From 2015 to 2017 (the blue years), there were roughly the same number of nest boxes at COPR and LLC.

From 2018 to 2022 (the brown years), there were zero boxes at COPR and 22 boxes at LLC.

TRES	**LCA**		**LLC**		**COPR**	
TRES Year	**# per Sighting**	**# of Nest Boxes**	**# per Sighting**	**# of Nest Boxes**	**# per Sighting**	**# of Nest Boxes**
< 2005	15.1	0	1.0	0	10.0	0
2005	15.0	0	0.0	0	8.0	0
2006	0.0	0	1.0	?	3.6	?
2007	12.0	0	1.0	?	3.6	?
2008	3.0	0	3.0	?	5.2	?
2009	5.0	0	21.7	?	1.5	?
2010	48.8	0	5.7	?	1.8	?
2011	32.8	0	10.0	?	9.0	?
2012	12.4	0	13.2	12	8.8	21
2013	15.7	0	10.0	11	11.8	17
2014	12.2	0	13.1	11	11.1	20
2015	14.4	0	5.0	11	2.9	16
2016	47.8	0	7.7	14	4.6	16
2017	12.6	0	6.4	14	6.2	16
2018	8.5	0	11.1	22	5.9	0
2019	4.3	0	13.2	22	4.8	0
2020	12.9	0	9.7	22	5.7	0
2021	10.0	0	9.0	22	3.5	0
2022	11.4	0	9.7	22	3.9	0

Fig. AP5m TRES - # per Sighting by Area and Number of Nest Boxes

There are, perhaps three major factors affecting these data.

1. Suitability of the local environment for the particular specie; e.g., food supply, etc.
2. Necessity for nest boxes for nesting habitat
3. Influx of population due to migration

4. Degree of competition for available boxes by other species; i.e., WEBL.

Sorting out the relative effects of these factors for all three of the locations at once seemed rather complicated. So, we took a more piece-mill approach.

First, comparing LLC to COPR from 2005 to 2008, COPR has roughly 3X the # per sighting than LLC.

Then, abruptly for 2009 and 2010, # per sighting at LLC jumped to be 3X-to-10X greater than at COPR. Possibly, nest boxes in significant numbers were beginning to be put out at LLC and had not yet been introduced at COPR.

From 2011 to 2014, # per sighting was roughly equivalent for LLC and COPR, with roughly twice as many boxes at COPR than LLC. This could be an indication that the environment for TRES was superior at LLC or that the area served by the boxes at LLC was a bit less than half of the area served by the boxes at COPR.

From 2015 to 2017, both # of boxes and # per sighting were roughly equivalent for LLC and COPR. In both cases, the # per sighting was roughly half to one-third of what it had been in the interval 2011 to 2014. We do not understand why this may be.

After the end of the 2017 nesting season, the nest boxes were removed from COPR.

From 2018 to 2022, the # per sighting at COPR remained the same as it had been for the interval 2015 to 2017 and that was roughly one-third the # per sighting at LLC; which now had nearly twice as many boxes as it had in the previous period.

The COPR observations would indicate that the addition of nest boxes to COPR in 2011 caused a doubling or tripling of # per sighting. However, the elimination of nest boxes after 2017 did not seem to materially affect the # per sighting. So, no consistent conclusion.

The LLC observations show a jump in # per sighting in 2008 and a huge jump in 2009, likely due to the introduction of sufficient numbers of nest boxes and the # per sighting remained relatively constant through 2014 after which it fell by roughly half and remained so, even though the numbers of nest boxes did not appreciably change. From 2018 thru 2022, both the # per sighting and the number of nest boxes nearly doubled. So, for LLC the # per sighting and the number of nest boxes do seem to track.

Additionally, for both LLC and COPR, the period from 2011 to 2014 had an elevated # per sighting beyond what one would expect from the numbers of nest boxes present. It would seem that there were some other factors operating that attracted a larger number of TRES to these areas.

LCA had no nest boxes during this time and is a relatively natural habit with no housing developments around it as do LLC and COPR. LCA's # per sighting is often higher than for LLC and COPR, but is more highly variable. This variablility is likely due to the lesser frequency of observation and the sporadic appearance of large flocks of migrating birds, not seen at LLC and COPR. If we take out the outlier, migratory data, the LCA result is roughly equivalent to LLC's with nest boxes. One could possibly say that LLC is more nesting-site limited than food-supply limited.

Taking another look at the COPR results, perhaps one could say that COPR is food-supply limited but not so much nest-site limited.

And, perhaps, putting a thousand nest boxes at LCA could result in a huge population remaining at LCA for the whole nesting season.

APPENDIX 6

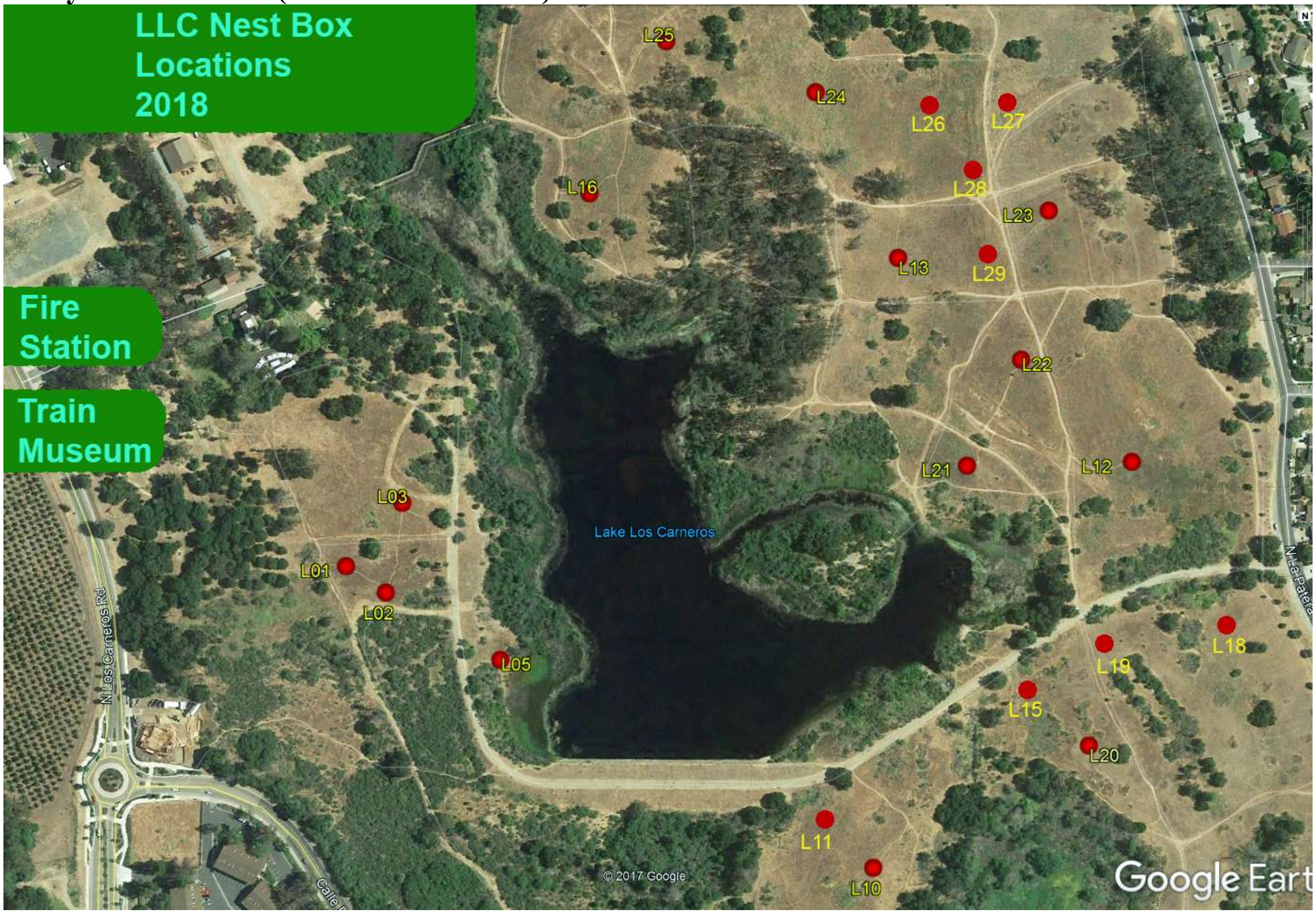
Santa Barbara Audubon Nest Box Project-Reference Guide

December 2022

Background: Tree Swallows and Western Bluebirds are cavity nesters that naturally nest in tree cavities (often made by woodpeckers). Human development often removes many trees and those that remain are often groomed in a way that minimizes dead branches (most appropriate for cavity nests). Such habitat disturbance is the likely reason why tree swallows and some other cavity-nesting species had dropped to the status of being an uncommon breeder around Santa Barbara.

Purpose of Study: Continue gathering data for analysis of known/suspected nest box successes and failures in an attempt to increase future fledging success. Generally, observe Tree Swallow and Western Bluebird behavior with respect to the environment – timings of nesting, egg-laying, fledging – unusual behaviors with respect to mating, competitors, food selection, etc.

Study Area 1: LLC (Lake Los Carneros)



Lake Los Carneros is located in the center of the park, at the end of Los Carneros Road, just past Highway 101. There is ample parking near the fire station and Train Museum, right off Los Carneros Road.

Example Data Sheet for our Study

Nest Box Data

Nest Status: MT=Empty/Clean, FF=Few Fibers, RNB=Ring of Fibers-NoBottom, CC=Complete Cup, WF=With Feathers, NF=No Feathers, A=Active (eggs or nestlings)

FLAG=Flagged - use protocol when opening

2018 **Nestling Stage**: JH=Just Hatched, DO=Downey, PP=PrePin, EP=EarlyPin, MP=MidPin, LP=LatePin, BR=Brush, QV=QuarterVane, HV=HalfVane, FV=FullVane

TRES = Tree Swallow HWRN = House Wren

WEBL = Western Bluebird VGSW = Violet Green Swallow

Locale

LLC Lake Los Carneros **DATE** **DATA Collectors**

BOX #	**Time**	**Bird Taxon**	**Nest Status**	**Eggs #**	**Nestlings # Live**	**Nestling Stage**	**Nearby Activity**	**General Remarks**	**Banding Remarks**

Data Field Definitions

Location LLC = Lake Los Carneros

Date	Use YYMMDD format for ease of ordering the data
Data Collectors	The initials of the people in the data collection group
Box #	The specific Box being observed
Time	The time range from start to finish. (10:35 – 12:15). Do not inspect boxes before 9am as not to risk disturbing egg-laying.
Bird Taxon	Species currently using box for nesting: **TRES** = Tree Swallow **WEBL** = Western Bluebird **HWRN** = House Wren **VGSW** = Violet Green Swallow **UNK** = Unknown
Nest Status	**MT**=Empty/Clean **FF**=Few Fibers **SF**=Some Fibers (unorganized) **RNB**=Ring of Fibers, No Bottom **CC**=Complete Cup **WF**=With Feathers **NF**=No Feathers **A**=Active (eggs or nestlings) **2N=**Second Nest (previous nestlings have fledged)
Eggs	Number of Eggs present (can leave blank, if zero)
Nestlings	Number of Live Nestlings Present (can leave blank, if zero). Record Dead Nestlings in the General Remarks Section
Nestling Stage	Stages of Nestlings: (see photos for more details) **JH**=Just Hatched – Tiny, naked (Day 1) **DO**=Downy-a bit larger, some down feathers, no dark feather tracks (under skin)(Day 2-3) **PP**=Pre-pin-dark feathers seen developing within skin of wing (Day3-5) **EP**=Early Pin - pin feathers just protruding from wings (Day 6) **MP**=Mid-Pin - pin feathers<1/4 inch (Day 7-8) **LP**=Late Pin - pin feathers >1/4inch (Day 8) **BR**=Brush - feathers with small “brushes” at tip (Day 9) **QV**=Quarter Vane - Feathers are 3/4 sheathed, ¼ opened (Day 10-11) **HV**=Half Vane – feather with only small sheath visible (Day 12) **FV**=Full Vane – sheath cannot be seen on a resting bird (looks fully feathered (Day 13-19). Be particularly careful in lowering the box and opening the top during this period. **Do not handle the birds.**
Nearby Activity	Bird species or mammals / humans active near box (within 200ft)

General Remarks	Relevant Observations: Details on all items removed from box (e.g., bad eggs, dead nestlings, nesting material, etc.) Details on evidence of mortality (**this is particularly important!**) Details on evidence of parasites / fly maggots / ants / mites Unusual Behavior of nestlings Behavior of adults Details of your disturbance (if any) Details on problems with nest box (needs maintenance etc.) Other
Banding Remarks	Note if parents are banded, banding numbers of dead nestlings, etc.

Nest Stages (before eggs are laid)

Few Fibers

Some Fibers

Fiber Ring

Complete Cup

No Bottom **With Feathers**

Eggs: The two on the right are addled (bad).

Eggs: Note egg color (pink, white, blue, ….)

Warning!! Do not check boxes before 9am. Females normally lay their eggs around dawn, or shortly after. Females disturbed in the act of laying could desert their nest!!

Nestling Stages

Hatch

Downy

Pre-Pin

3 Days

Early Pin

6 Days

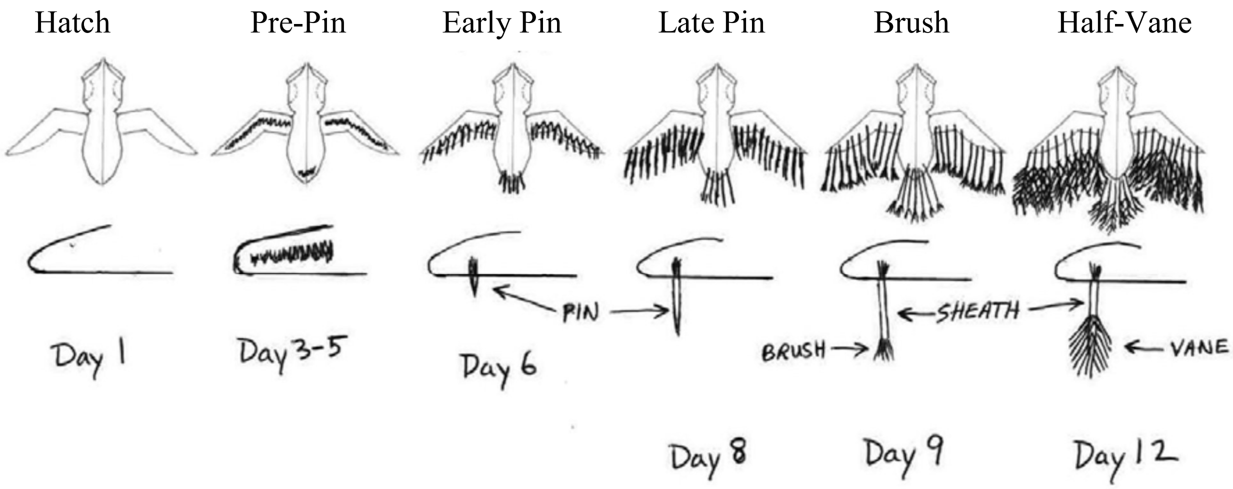
Mid-Late-Pin

9 Days

Half-Vane

12 Days

Stages of Flight Feather Development



Mid-Pin Nestling

Tail Feathers: One-third to Half-Vane

Half-Vane

Take a close look at the 12-day nestling's wing, below. Notice how the flight feathers have partly erupted from their sheaths, so they look like little paintbrushes. If you find nestlings in a box have flight feathers more erupted than these, leave them alone!! Handling them for any reason, even banding, risks premature fledging and a relatively decreased survivorship of such birds.

Full-Vane

Warning! If startled, older nestlings (>12 days) may try to leap out of the box and try to fly before their flight feathers and muscles are ready. If you return them to the box, they usually jump back out again. Nestlings that try to fledge prematurely often die. When frightened, they normally hunker down and freeze. If you are slow and careful, you can look at them, but do not attempt to touch them.